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Introducing emotion-based personalisation to cancer websites

The impact of emotions on website personalisation and
reuse intentions

by

Sunčica Hadžidedić

A thesis submitted in partial fulfilment of the requirements for the
degree of

Doctor of Philosophy in Computer Science

Supervisor: Dr. A. I. Cristea

University of Warwick, Department of Computer Science

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In the name of God, the Compassionate, the Merciful.

I dedicate this work to a person of high principles, a role model, a strong, smart and accomplished woman, and a great friend, who passed away too early.

To my mom, and all the people who have lost the battle to cancer.

Declaration

This thesis is submitted to the University of Warwick in support of my application for the degree of Doctor of Philosophy.

I hereby declare that the work presented in this thesis has been composed by myself, except in the cases where acknowledged, and it has not been submitted in any previous application for any degree.

Sunčica Hadžidedić

Signature:

A handwritten signature in black ink, appearing to read 'Sunčica' followed by a stylized flourish.

Date: 23 January, 2018

Publications

This research has led to the publishing of two journal papers, one conference paper, one journal paper awaiting a response, two planned journal papers.

Journal papers

1. S. Hadžidedić Baždarević and A. I. Cristea, "Do personalisation and emotions affect the use of cancer-related websites?," *Online Information Review*, vol. 41, no. 1, pp. 102-118, 2017. (IF: 1.152)
2. S. Hadžidedić Baždarević and A. I. Cristea. "How emotions stimulate people affected by cancer to use personalised health websites," *Knowledge Management & E-Learning: An International Journal*, vol. 7, no. 4, pp. 658-676, 2015. (2015 SNIP: 0.521)

Conference paper – published and presented

3. S. Hadžidedić Baždarević and A. I. Cristea, "What do people affected by cancer talk about online? Text analysis of online cancer community usage in Bosnia and Herzegovina," *The Fifth International Conference on Social Medial Technologies, Communication and Informatics (SOTICS)*, IARIA, Barcelona, Nov 15-20, pp. 8-13, 2015.

Submitted and planned journal papers

4. S. Hadžidedić Baždarević, A. I. Cristea, D. G. Watson. "Exploring the effect of emotions and personalisation on cancer website use and reuse," *Computers in Human Behavior* (submitted March 2017). (IF: 2.694)
5. S. Hadžidedić Baždarević, A. I. Cristea, D. A. Al-Qudah, D. G. Watson, M. Tirak, O. Rababah. "Towards emotion-based personalisation on cancer websites: Can emotions

- predict preference for personalisation features?,” *User Modeling and User-Adapted Interaction* (currently being written). (IF: 3.037; SNIP: 6.60)
6. S. Hadžidedić Baždarević, A. I. Cristea. “Framework for exploring the influence of emotions on personalisation and intentions to reuse a cancer website,” *Behaviour and Information Technology* (planned for 2017). (IF: 1.211)

The three published papers are based on the findings obtained in the first two studies of this research. The *paper (1) published in the Online Information Review journal* was based on Study 1 findings on the state of the art of personalisation adoption on health websites (see Chapter 3: RQ 1.1, RQ 1.2 and RQ 2.1.3). The *Knowledge Management & E-Learning (KMEL) paper (2)* was based on Study 2 findings that tested the conceptual framework relations. The conceptual framework, research methodology and findings presented in the paper are covered in Chapter 3, Chapter 4 and Chapter 7. The *conference paper (3)* explored the type of cancer information cancer affected people seek online (RQ 1.1). The findings of this paper have been used in the development of the PORT cancer website, i.e., identifying the website content type, content indexing, and defining cancer-related interests for user profile customisation (see Chapter 5).

The *fourth paper*, which has been submitted to the *Computers in Human Behavior (CHB) journal*, focuses on the conceptual framework relations between emotions, personalisation and reuse intentions (based on Study 3), which are the topics of Chapter 3, Chapter 4 and Chapter 7. The *fifth paper*, planned for submission to the *User Modeling and User-Adapted Interaction journal*, covers the implementation of emotion-based recommendations and adaptation to the PORT cancer website (see Chapter 5). Moreover, the paper evaluates user preference for emotion-based personalisation (see Chapter 4 for Study 4 and Study 5 methodology, and Chapter 6 findings). The *paper (6)* intended for the *Behaviour and Information Technology journal* will extend the KMEL and CHB papers, by re-evaluating the extended conceptual framework (see Chapter 3). It will address the influence of individual pre-use emotions on personalisation features and the extracted rules for emotion-based personalisation for cancer websites (Chapter 5, Chapter 7 and Chapter 9).

Co-authored papers

The papers I have co-authored in the process of this research have dealt with personalised and adaptive systems in e-learning, e-shopping and e-advertisements. The resulting benefits for this research were: exposure to the latest research in personalisation in different online domains; designing controlled experiments and exploring different methodologies in sampling, data collection and pre-processing; evaluating different measures of user acceptance that were considered in this thesis as well (e.g., ease of use, usefulness and usability), and experimenting with different statistical tests.

The co-authored papers include:

7. D. A. Al-Qudah, A. I. Cristea, S. Hadzidedic Bazdarevic, R.M.H. Al-Sayyad, and S. Al-Saqqah. "A Taxonomy-based Evaluation of Personalized E-advertisement," *Computer and Information Technology; Ubiquitous Computing and Communications; Dependable, Autonomic and Secure Computing; Pervasive Intelligence and Computing (CIT/IUCC/DASC/PICOM), 2015 IEEE International Conference on*, IEEE, Liverpool, UK, pp. 395-402, 2015.
8. D. A. Al-Qudah, A. I. Cristea, S. Hadzidedic Bazdarevic, S. Al-Saqqah, A. Rodan and W. Yang. "Personalized E-advertisement and E-shopping Experience: Recommending User Targeted Ads," *e-Business Engineering (ICEBE), 2015 IEEE 12th International Conference on*, IEEE, Beijing, China, 23-25 October, pp. 56-61, 2015.
9. L. Shi, A. I. Cristea, and S. Hadzidedic. "The critical role of profiles in social e-learning design," *Proceedings of the 15th Annual Conference on Information technology education*, ACM, pp. 71-76, 2014.
10. L. Shi, A. I. Cristea, S. Hadzidedic, and N. Dervishalidovic. "Contextual Gamification of Social Interaction–Towards Increasing Motivation in Social E-learning," *International Conference on Web-Based Learning*, Springer International Publishing, pp. 116-122, 2014.
11. L. Shi, A. I. Cristea, and S. Hadzidedic. "Multifaceted open social learner modelling," *International Conference on Web-Based Learning*, Springer International Publishing, pp. 32-42, 2014.

Abstract

Affective computing has received substantial attention in the recent time. However, its application to personalised online cancer services is understudied. Therefore, this research primarily explores the role of emotions in predicting the preference for personalisation features, and in forming behavioural intentions in cancer website usage. Secondly, this research seeks to understand whether users of cancer websites prefer to be offered emotion-based personalisation to other options – personalised or non-personalised.

Emotion-based personalisation was implemented, in several phases, on the cancer website developed for the purpose of this research. A number of controlled experiments were carried out, in which users interacted with the cancer website and evaluated its personalisation features.

The findings confirm that users more likely reuse a cancer website when they are satisfied with its personalisation services and find the website usable. Moreover, both negative emotions (e.g., sadness and fear) and positive ones (e.g., interest) encourage reuse intentions. Post-use negative emotions are primarily influenced by the website's usability, while satisfaction with personalisation and usefulness of adaptive and adaptable services intensifies positive emotions.

The website is perceived usable and it induces user satisfaction when its personalisation is considered useful. The findings imply that discrete emotions (of the nine basic emotions studied here) stimulate or discourage interaction with certain website features and content. Moreover, emotions experienced at the start of website use affect the perception about the usefulness of individual features available on the website. Generally, users experiencing positive emotions are eager to explore the website and be involved in the tailoring process. The effect of negative emotions is more difficult to generalise; it depends on the specific emotion and the personalisation feature in question. Overall, negative emotions are more likely to inhibit the use or perception of website features that require providing user personal information and interests, or entail extensive engagement from the user side.

With regard to the second aim, this research suggests that emotion-based personalisation on a cancer website is preferred, however not significantly over generic personalisation or no personalisation at all. Nevertheless, the findings urged for further research. The survey and interview results consistently showed that: personalisation was perceived as useful, users were satisfied with it, that the website with emotion-based personalisation had the highest usability and most users prefer that type of personalisation. Moreover, repeat visitors and long-time cancer website users, who have been directly affected by cancer, decisively desired emotion-based personalisation.

Overall, this research provides multiple theoretical and practical implications for personalisation adoption on cancer websites and stimulating reuse intentions. It recommends rules for adaptation and personalisation algorithms that incorporate user emotions. Moreover, it extends the existing theory and proposes a framework for understanding the emotion- and personalisation-related factors that influence intentions to revisit and reuse a personalised cancer website.

List of abbreviations

4-AFC	4-Alternative Forced Choice
A1	Emotion-based content recommendations algorithm for existing user
A2	Emotion-based content recommendations algorithm for new user
A3	Emotion-based adaptation algorithm
AIDS	Acquired Immune Deficiency Syndrome
AIE	Average Intensity of Emotions
AMT	Amazon Mechanical Turk
AN	Adaptive Navigation
ANOVA	Analysis of Variance
AP	Adaptive Presentation
ARS	Affective Recommender Systems
B&H	Bosnia and Herzegovina
BBC	British Broadcasting Corporation
BSREC	Biomedical and Scientific Research Ethics Committee
CB	Content-based Filtering
CF	Collaborative Filtering
CG	Control Group
CNR	Content Not Read
CORE	Computing Research and Education
CP	Content Personalisation
CSS3	Cascading Style Sheets, latest standard
CSUQ	Computer Usability Questionnaire
D	During-website-use Emotions
DEF	Default PORT website (Phase III version)
DES	Differential Emotions Scale
E	PORT website with emotion-based personalisation (Phase IV)
ET	Emotion Tool
EU	European Union
EXT	PORT website with emotion-based personalisation (Phase III)

FNN	False Nearest Neighbour Algorithm
GRAPPLE	Generic Responsive Adaptive Personalized Learning Environment
H	Hypothesis
HCI	Human-Computer Interaction
HIV	Human Immunodeficiency Virus
HTML5	Hypertext Mark-up Language, Fifth Version
IARC	International Agency for Research on Cancer
IBM	International Business Machines
ICC	Interclass Correlation
KAI	Knowledge and Awareness Infrastructure
KB	Knowledge Base
kNN	k-Nearest Neighbours Algorithm
L	Login emotions
LIWC	Linguistic Inquiry and Word Count
MI	Matching Interests
MySQL	My Structured Query Language
N	Number of Responses/Participants
NAAS	Negatively Valenced Aggregated Affective State
NE	Number of Emotions Reported
NEI	Negative Emotions Mean Intensity
NGO	Non-Governmental Organisation
NMC	Number of Matching Characteristics
NMI	Number of Matching Interests
OCC	Ortony, Clore, and Collins Theory
P	PORT website with generic personalisation (Phase IV version)
PA	Personalisation Approach
PAAS	Positively Valenced Aggregated Affective State
PAD	Pleasure-Arousal-Dominance
PCA	Principal Component Analysis
PCS	Personal Coaching System
PEI	Positive Emotions Mean Intensity

PHP	Hypertext Preprocessor
PHR	Personal Health Record
PRE	PORT website with generic personalisation (Phase III version)
QUIS	User Interface Satisfaction
R	Recommendations
RI	Reuse Intentions
RMF	Ratio of Mismatched Features
RObj	Research Objective
RP	Research Proposition
RQ	Research Question
RTSEA	Real-Time Subjective Emotionality Assessment
SAM	Self-Assessment Manikin
SCS	Support for Customer Search
SD	Standard Deviation
SIC	Same Interest Category
SPSS	Statistical Package for the Social Sciences
SSST	Sarajevo School of Science and Technology
SUD	Support for User Decisions
SUS	System Usability Scale
SVM	Support Vector Machine
UI	User Interface
UK	United Kingdom
UPI	User Profile Information
US	United States
UTAUT	Unified Theory of Acceptance and Use of Technology
UX	User Experience

Chapter 1

Introduction

Cancer is the second leading cause of death worldwide [1]. The latest statistics show there were 14 million new diagnoses and 32.6 million people already living with cancer in 2012 [2]. A further disturbing realisation is that the scope of cancer-effect goes beyond cancer sufferers.

The battle with cancer is led by cancer patients, but also their caregivers - both healthcare professionals and the support network of family and friends [3]. Thus, based on the global *cancer prevalence* (the number of people living with cancer [4]) in 2012, even if each of the 32.6 million cancer patients had only two caregivers, that makes more than 65 million people who were actually affected by cancer, generally, for the duration of 1-2 years when caregivers are most needed [3]. It is thus evident that the scope of the cancer-effect is colossal.

Cancer has been researched from multiple perspectives, in attempts to reduce the burden of this disease. Principally, medical research has covered topics of prevention and causes, clinical trials, developing various therapies, personalised medicine, and surgery [5, 6]. Moreover, there have been significant contributions from the computer science field in image processing and digital pathology for cancer prediction [7, 8], and evaluation and development of technologies and learning tools for cancer diagnosis [9, 10].

Nevertheless, while most of the research attention has been directed towards prevention and searching for a cure, we must not forget supporting the people currently fighting this disease. In addition to direct medical treatments and professional care, cancer patients, as well as their caregivers, need constant in-between care, including mental and emotional, diet and physical support. Achieving this only with medical staff or cancer support groups is extremely difficult. Hence, *online support of health websites is crucial*, as these are widely accessible and available resources to various types of users. While cancer-related online resources are available, the question is whether they address the needs of

the individual users, and therefore whether they provide adequate and useful support. Personalisation is one of the efficient means for tailoring a service to the needs and characteristics of each user. However, adoption of personalisation on cancer websites is lagging behind, and research in this area is lacking; it is therefore the main topic of the research presented in this thesis.

1.1 Problem statement

Health-related Web-based services are numerous [11], yet, they continue to be criticised for the low usability, presentation and usefulness of content [12]. Improvements are sought by taking into concern target users perceptions about and usage of these technologies [13]. One of the effective ways to improve "website stickiness" [14] is by introducing **personalisation** [11, 15, 16]. The majority of Internet users desire to be provided personalisation services [17], which have many benefits [18]. An important benefit of personalisation for online health services is the improved relevance of presented content [19]. It is also one of the most important usability and functionality factors determining users' preference for e-health websites [11].

Personalisation of online health content is defined as "the adaptation of health-related Web content and applications to characteristics associated with a specific user" [20]. Tailoring online health information to individual users [16] leads to content better matched to users' health literacy and situation [21]. Thus, the variety of users with different characteristics, needs and preferences can use health-related resources on the Internet in a more efficient manner [21]. As a result, patients are better informed about their health problems [16, 22] and actively participating in personal healthcare [23].

Commonly, personalisation in eHealth has been seen in the form of personalised treatments, interventions or medicines [24-26], or has been applied to personal health records (PHRs), health education and, more recently, search outcomes [20]. However, the adoption of personalisation technologies in online health services has been slow and neglected [27-30], compared to other online domains, such as entertainment, e-learning and e-commerce [31]. Some global health websites, primarily US- and EU-based, offer a

limited number of personalisation features. However, these health websites are mainly commercial endeavours, based on proprietary research. Moreover, they do not make it transparent what data was used for user profiling and segmentation, whether users were engaged in the process of feature selection, and how the decision was made which features to implement. Importantly, research on *systematic application of personalisation features to cancer websites* is lacking [20, 21, 32].

It can be argued that personalisation services adopted in other online domains may be directly applicable to cancer websites. However, research indicates that no single formula works across different online domains [18]. Moreover, it is necessary to research and confirm the argument. This can only be accomplished by studying the cancer-affected population, exposing them to a comprehensive set of personalisation features on a cancer website and obtaining their feedback about the services they had a chance to experience. Effectiveness of personalisation depends, in the end, on how well it reflects the needs of the target users. The challenge is considering the online context and the unique set of target users' characteristics [13].

With respect to user characteristic, emotions have long been neglected in personalisation research. Traditionally, users were profiled by demographic, transactional, factual and behavioural data [33]. The set of traditional user characteristics [33] includes: knowledge, goals, background, experience, preferences, activities, demographic information, socio-economic information. Personality traits have recently been considered for user segmentation [34, 35]. Nevertheless, it is suggested that system personalisation should be founded on a comprehensive user profile [33], which requires taking into account, among others, users psychological traits, including their emotions [36].

Emotions are one of the main traits of human beings, influencing their actions and behaviour [37]. This research argues that people affected by cancer are strongly characterised by these short-term, transitory states. Cancer is a disease which has a particular side-effect on emotions and **emotional health** of the person affected by it [38, 39]. According to the *Five stages of grief* framework [40], dealing with loss – loss of health that cancer patients experience or loss of a loved one that their family members or

friends experience - goes through five stage: from denial, anger, bargaining, depression to acceptance. Each of these stages is laden with different emotions. The changes in the psychological state of the cancer-affected population are particularly characterised by the more frequent experience of negative emotions [41, 42], which reflect on their actions and behaviour. Hence, they need help in coping with the emotional impact of the disease [39]. Consequently, this research argues that it is necessary to understand the role emotions play in shaping the preferences and behavioural intentions of website users, particularly the cancer-affected users.

Research on improving human-computer interaction (HCI) [43-45] has given substantial attention to **affective computing** in the recent time [46]. Computer systems capable of recognising affective states are able to respond to user's frustration and changeable mood by providing encouragement and comfort [43]. Such systems are, therefore, perceived as more effective and natural [43]. Likewise, a system responsive to user emotions is able to provide improved cancer-related support.

Emotions have only recently been introduced in the online personalisation research. It has been only a couple of years that Facebook started enabling their users to provide an affective response in addition to just expressing a liking [47]. Since 2007, there have been several studies on emotion-based recommender systems [48, 49], such as movie [50], tourism [51] and music recommendations [52]. Other recent studies explored the relation between personalisation and emotions in e-shopping [53] and e-learning [54]. However, to the best of the author's knowledge, emotions have not been studied in relation to personalised cancer websites.

This research, therefore, *proposes that providing personalised online cancer services requires recognising users' emotions, based on which it would be possible to provide more adequate support, as well as determine whether the services were preferred and could be recommended in similar affective states in future interactions with the system.*

1.1.1 Cancer support in Bosnia and Herzegovina

To thoroughly explore the possibilities of cancer website personalisation, another important factor to consider was building the foundation of the research in conditions which were not tampered by or exposed to previous attempts of online health personalisation.

Bosnia and Herzegovina (B&H) was selected as such a context. The B&H population reflects the needs of a large portion of the global population, who would highly benefit from online support due to the poor state in healthcare [55], and to whom the websites in English are not accessible, due to language barriers. Importantly for this research, none of the *online health resources in B&H provide personalisation* for its users. Moreover, there is no available research on the use and personalisation of online health services in B&H.

1.1.2 Broad applicability of the research

Essentially, broader applicability of research is desirable and important. The case of B&H was used to build a foundation for my research. B&H context was useful to identify target users' requirements for cancer website personalisation in an understudied environment, which has not been tampered by prior personalisation attempts in this domain. Moreover, B&H is a good representative of other understudied environments facing similar issues related to cancer support - e.g., poor state of healthcare, poor online cancer support, language barriers, etc.

Nevertheless, to ensure broader research applicability, representatives of the global cancer-affected populations were recruited for the evaluation of the personalised cancer website developed for this research. Three of the evaluation studies I carried out sampled populations from: the US; different European countries; some Asian countries, including Jordan and Malaysia; and some from Latin America. Consequently, this research ensured external validity and generalisability of its results.

1.2 Research questions and objectives

The **goal** of this research was *to explore introducing personalisation, and specifically emotion-based personalisation, to cancer websites*. Thereby, this research first had to establish whether and how emotions influence the preference for website content and features. Secondly, based on this understanding, to implement emotion-based personalisation to a cancer website, and thereafter evaluate whether users desire such services. Hence, two **main questions** guided the research:

- RQ 1. Do people affected by cancer prefer to have emotion-based personalisation, generic personalisation, or no personalisation on a cancer website?
- RQ 2. Do emotions influence the perception about personalisation and intentions to reuse a personalised cancer website?

The two main research questions – RQ 1 and RQ 2 – are further divided into *sub-research questions*, as presented in Chapter 3. The **objectives** that address the research questions are listed in Table 1.1.

Table 1.1. Research objectives

RQ	Number	Objective description
RQ 1, RQ 2	RObj1	Identify who the cancer-affected people are and review the state of the art in online health service personalisation.
RQ 1	RObj2	Explore and extract personalisation features for a cancer website.
RQ 1, RQ 2	RObj3	Develop a personalised cancer website, with emotion-based adaptation and personalisation, founded on the identified personalisation requirements (RObj1 and RObj2).
RQ 2	RObj4	Develop and refine a conceptual framework for exploring how emotions affect reuse intentions for personalised cancer websites.
RQ 1	RObj5	Evaluate the personalised cancer website. Explore user preferences between non-personalised, personalised and emotion-based personalised services on cancer websites.
RQ 2	RObj6	Conduct experiments on target user interaction with the personalised cancer website. Analyse the relationship between user emotions experienced at the start and during website use, and the choice of features and content to interact with, as well as the perception about the feature usefulness.
RQ 1	RObj7	Adjust and extend the website's emotion-based adaptation and personalisation algorithms, based on the findings about the relations between emotions and website features and content (RObj6).
RQ 1	RObj8	Confirm target user preferences for emotion-based personalisation.

1.3 Development of a personalised cancer website

In answering RQ 1 and RQ 2, one of the main objectives (RObj3) of this research was the *development of a cancer website that provides emotion-based personalisation* for users who are directly and indirectly affected by cancer. For these purposes, *collaboration* was established with one of the *cancer associations* from B&H – **PORT Association**.

PORT is a non-governmental association, founded in 2011, to assist people suffering from malignant diseases. The association's mission is to raise awareness in B&H about the use of ports in chemotherapy in order to ease the treatment for cancer patients. PORT aimed to empower B&H cancer-affected population through knowledge dissemination. With respect to this, the association established its Web presence in September 2012. By the end of 2013, they had a small member base of around 30 registered users, but larger Facebook presence with more than 200 followers.

The *PORT portal* for B&H cancer patients and their caregivers focused on publishing cancer related news, updating and organising the virtual community, and foremost providing a knowledge database of cancer-related information and articles. The portal was built in the form of a blog, using Wordpress as the underlying technology; however, it provided no personalisation services. For the purpose of this research, a proposition was made to the PORT Association in October 2013 to improve their online services by developing a personalised PORT website. The aim was to preserve the online identity of the PORT Association, to migrate the content from the original PORT website, but to introduce a new design and new features, focusing on personalised services.

In turn, several benefits stemmed from collaborating with the PORT Association for this research. First was having access to the association's existing online member base. Second was having available the initial pool of content which was provided on PORT's original website and their Facebook page. Additionally, the advantage was using the name and brand of a relatively established and trusted cancer association in B&H. Consequently, the collaboration with the PORT Association assisted in alleviating the *cold start* problem that the majority of newly developed personalised systems face.

Instead of using existing systems, it was *opted to build the website from scratch*, in order to have access to all website functionalities. Moreover, in system evaluations, this approach made it possible to expose users to the full-feature set, and thus obtain comprehensive feedback on which to base further system improvements. In addition, having ownership of the website enabled exploring website feature adaptation and personalisation to different parameters of the user profile, including those that have not been implemented on other existing systems, as are user *emotions*.

The website **development** was divided into four **phases**, each iteratively expanding and adjusting the website features and functionalities. The final version of the personalised PORT website offers its users a range of services, including:

- Content related to news and articles, blogs, forum discussions and chatroom messages.
- And more than 30 different types of personalisation features; the core are emotion-based personalisation and adaptation services currently not available on other cancer websites – from content recommendations taking into account user emotions, to adaptive navigation triggered by emotions.

1.4 Research contributions

This research, therefore, made several **contributions**, specified here, and further expanded on and linked to the gaps in the existing literature in Chapter 2 (Section 2.6).

1. This research provided an insight into personalisation preferences of cancer website users.
 - a. It showed the level and type of personalisation that cancer website users prefer, and whether they prefer personalisation services at all.
 - b. By implementing personalisation features in a systematic way, by obtaining user feedback, and applying an academic approach to system evaluations, this research produced reliable implications about the

different personalisation features target users would use and like to have offered on a cancer website.

2. Research on emotions and affective computing was applied to an understudied context – specifically cancer websites with personalised services.
3. This research provided an understanding of how emotions correlate with user perception of personalisation, to improve user models for cancer website personalisation.
4. The findings of this research can be used as guidelines for introducing emotion-based personalisation to cancer websites.
5. Finally, this research indicates the factors that influence the intentions to reuse a personalised cancer website. This research proposed and evaluated a conceptual framework linking user emotions and the perception about cancer website personalisation with intentions to revisit the website.

Therefore, cancer website providers could harness the results of this research to improve online support available to people affected by cancer, and in turn increase target users' willingness to reuse and engage with these services.

1.5 Thesis layout

This thesis is organised around nine chapters. The current chapter is an introduction to the topic of the research, identifying the current problems in online personalisation research, specifically applied to cancer websites. It highlights the goal, questions and objectives of the research, toward introducing emotion-based personalisation to cancer websites.

The next chapter reviews the background and related literature. It gives an overview of the background concepts related to online personalisation, user profiling, recommendation techniques, differences between adaptive and adaptable approaches in personalisation, as well as the emotions-related concepts and measuring instruments. The chapter further introduces different applications of personalisation in online health systems, as well as personalised systems responsive to emotions.

The underlying research theories are discussed in Chapter 3. It presents the conceptual framework of this research. It details the sub-questions and defines the hypotheses addressing the relations between the proposed constructs. The chapter further explains each of the research factors, where they were adopted from or how they were developed.

The fourth chapter explains the methodology and design of the research. It covers the common methodology used in all the studies carried out within this research, from sampling, experiment design, data collection instruments, to data cleaning.

The methodology related to the design and development of the website is detailed in Chapter 5. The chapter presents the development framework, user-centric design of the system, and the distribution of development activities into four phases. Chapter 5 further presents novel algorithms for emotion-based content recommendations and feature adaptation for cancer websites. The chapter concludes with demonstrations of the emotion-based personalisation and adaptation on the PORT cancer website.

Chapter 6 and Chapter 7 report the findings of the five studies this research encompasses. The chapters present the unique methodologies and analyses applied to each of the studies. Chapter 6 addresses the findings for RQ 1, related to user preferences for emotion-based personalisation. Chapter 7 focuses on the results for research model relations, i.e., RQ 2. These two chapters report in detail the results of each hypothesis, and conclude whether the researched claims have been supported.

The discussion of the findings, in relation to the researched questions, is the focus of Chapter 8. Chapter 9, thereafter, introduces theoretical implications resulting from the revised relations of the proposed conceptual framework. Moreover, practical implications are outlined, in the form of guidelines for introducing emotion-based personalisation to a cancer website. Finally, conclusions are formed, within the limitations the research was carried out in, and recommendations for future research are devised.

Chapter 2

Background research and literature review

Chapter 2 reviews the state of the art in online health personalisation (RObj1). The chapter presents the background concepts and reviews the state of the art in the domains this research encompassed. The topics include: online health services, online personalisation, and their integration; emotions and affective computing; and, finally, existing research on emotions in personalised systems, specifically online health-related ones. The last section synthesises the information extracted from the reviewed literature and identifies the gaps in knowledge that this research tried to answer.

2.1 Online health services

Health information searching is the third most popular activity on the Internet [56, 57]. While the traditional ways of obtaining health information have come to a stand-still [58], there has been a noticeable increase in online health information usage [58-60]. For example an increase of 50% in European countries in the period 2001 to 2009 [58, 59], and an increase in the number of health websites [11].

Online health information seeking in different *demographic groups* does not coincide across different sources. Some claim it is more frequent among older people (50 to 64 years of age), and increases with education level [22]. Other sources [61] state that young people, in particular students, are more likely to use the Internet for health advice [62]. The latter findings are particularly useful in support of *sampling student populations for health website evaluations and experiments*, as was the case in this research.

Gender was repeatedly found to influence online health information searching [63]. Women seem to be more inclined to it [22, 64]. The Internet is the first source of health information for both men and women, however men have a higher tendency toward personal interactions [65]. The introduction of personalisation was seen as a means of gender equalisation in online health seeking [65]. Hence, the research presented here

explored the effect of gender and other demographic characteristics on personalisation services introduced to a cancer website.

The research presented in this thesis specifically focused on *online health information use by people affected by cancer*. *Online health information is used* by this population for various reasons – cancer patients search for treatments, medical information and social support [64], while others seek prevention related information or screening and risk evaluation [64]. In a US based study, approximately 40% of the sample used the Internet to search for cancer information [66]. Further US reports showed that Internet was the first source for cancer information, for those looking to inform themselves or to help someone else [67]. In a UK study, it was found that one of the three main reasons cancer patients used the Internet was for the wealth of available resources [68].

Research presented in this thesis sampled a global population of cancer-affected or cancer-interested users. Nevertheless, the foundations of the research were built on the perceptions and needs of people affected by cancer in B&H. This research was thereby aiming to *explore and compare the online seeking behaviour and topics of interest exhibited by the cancer-affected population in understudied environments, specifically non-English speaking, with poor online and offline healthcare services, as is B&H*.

The availability of online health resources presents significant support. However, the *sheer variety and amount of information often means health consumers are overwhelmed*, and have to look through large amounts of often irrelevant [21] or incomprehensible data [69]. It was shown that only 20% of those who seek cancer information online, managed to find all they were looking for [66]. This can negatively influence the users' willingness to revisit cancer websites, or even to continue the current visit. To reduce the negative effect, it was *advised that online health services address personalisation* as one of the key elements [27].

Several major *areas for improvement of Web-based health services* were identified in [21], including: defining user's personalisation needs and requirements more comprehensively, considering the variety of health patients and their medical conditions, and matching the personal context of a user with the information provided. Topaloglu et

al. [11] further implied that users want “highly personalised, easily and quickly accessible health information from memorable web sites that offer plain text information as well as additional services”. Thereby, the aim of this research was to *develop a highly personalised cancer website* (Chapter 5) *that would recommend its users personalised content*, thus speed up and ease access to relevant information, *as well as provide adaptation of website design and navigation*, to improve the ease of use and usefulness of website features.

2.2 Online personalisation

With the expansion of information fed to the Web, finding the specific “tree in the forest” has become increasingly more difficult. A popular concept used as a solution to this problem is **personalisation** [70]. Personalisation is commonly defined as *tailoring of content, information structure and information presentation, with the purpose of matching individual user’s needs and wants* [71-73]. While it is present in various contexts, this research is specifically interested in online or *Web personalisation*. A survey of Internet users suggests that 80% are interested in being provided with personalised services [17], and that they prefer such features [74].

The commonly cited **steps** [33] **of Web personalisation** process are: data collection, data pre-processing (modelling and classification), data analysis, and action recommendation. These are categorised into three main processes: user model acquisition methods, user model representation and secondary interfaces, and hypermedia adaptation production [75]. The third – production - stage determines what will be adapted and how, from among [76]: content personalisation, presentation personalisation, and user interface or structure personalisation. The *website developed for this research incorporated the three main steps of Web personalisation*, by acquiring user data, devising and representing user models through sets of rules, and finally personalising the website content and adapting the presentation of website features to the user model.

The applications of online personalisation range from features such as displaying a user name [77], to advanced features such as item (product, service or information)

recommendations [77, 78], user-enabled item customisation [77], and personalised web pages [78]. *More than thirty different personalisation features were applied to the cancer website developed for this research.* The selection was based on user feedback about a comprehensive list of personalisation options, compiled from relevant literature on online personalisation adoption in other domains [31, 33, 77], as well as taxonomies of adaptive hypermedia technologies [79, 80] (next section).

There are various personalisation techniques that enable the presentation of personalisation features, including filtering techniques, collecting user preferences, developing user profiles, determining user location [78]. **Filtering techniques**, the basis for content recommendations, include content-based filtering [76], rule-based filtering, collaborative filtering [76], Web usage mining, demographic-based filtering, agent technologies and cluster models [33]. To improve the quality of recommendations, the optimal approach for a specific context is often combining various techniques, as is the case with the hybrid approach or knowledge-based recommendations [51]. Explained in more detail in the next paragraphs are the techniques relevant for this research.

Content-based filtering looks at the items the user clicked on in the past to recommend items with similar characteristics [76]. Items are categorised based on their features. However, two preconditions have to be met for successful categorisation: collecting a certain amount of item information, and sufficient information about user behaviour on the website [76], both of which require time. This is known as the *cold-start* problem [76]. Hence, this research *employed content-based filtering to generate content recommendations for users who have used the system for some time, and have rated and expressed preferences for content* (further presented in Chapter 5). However, *for new users, whose preferences and behaviour is not known*, another technique was used – *collaborative filtering*. *Collaborative filtering*, as the name suggests, is based on some social component. In this technique, user characteristics are matched against those of other similar users [76], i.e., users with the most similar preferences and tastes [70]. Items selected by the most similar users are recommended to the current user [76], on the premise that the current/new user is likely to also prefer them [70]. Collaborative filtering is the most widely used recommendation technique [70].

Both content and collaborative filtering have certain drawbacks that have been dealt with in the more recent approaches, such as hybrid recommender systems [76]. Nevertheless, this research *opted for these two filtering techniques as they are the most popular and widely used ones*. Moreover, the aim here was not to explore the applicability of the alternative techniques to the cancer website domain, or to propose new solutions to recommendation techniques. Rather, it was to employ the existing, validated techniques to a domain they have not been commonly tested in. A further objective was to explore *extending these two techniques with emotion-based parameters*. The argument for incorporating emotions into filtering techniques was supported by the recent studies on context-aware recommenders, which state that “human factors such as users’ affective states matter during the recommendation process” [81]. They claim that emotions can be used as a resource in the process of content rating, “to feed content-based or collaborative filtering recommendation approaches” [81].

Another aspect to consider in online personalisation is where to place the control of the process – with the user or the system. In this respect, there are two main personalisation approaches - **adaptivity** and **adaptability** [82]. In adaptivity, the system autonomously performs adaptation [82], based on the gathered user data, and without any user involvement [76]. The adaptive approach allows for less user effort, and an impression of greater value of personalisation [83], however, also a sense of reduced user control [83]. Adaptability, on the other hand, relies on users to tailor the system to their preferences [76, 82], and as such is deemed a simpler approach [76]. It enables greater user control, but also requires more user time and effort [83].

Adaptivity and adaptability are not exclusive of each other, and can both be used within the same system [76]. Some studies, applied to personalised digital libraries, indicate that users perceive adaptive personalised system more positively than the adaptable [82]. They also show that user performance is improved in adaptive environments [82]. On the other hand, a user acceptance study [84] on fully adaptive, semi-adaptive, and adaptable e-commerce interfaces, pointed towards the need to balance and distribute the control process between the user and the system in order to positively affect user’s behavioural intentions. Users preferred the semi-adaptive approach [84]. Other studies also show that

enabling users to have control over which of their personal information is revealed diminishes the negative effects of adaptivity [85]. Nevertheless, specific preferences that cancer website users have for adaptivity or adaptability are not evident from the reviewed literature. Thus, this research *addressed cancer-affected user preferences for a personalisation approach* (Chapter 7), and *evaluated the implementation of both approaches to the cancer website developed here* (Chapter 5 and 6).

2.2.1 Adaptive hypermedia

Adaptation, essentially, means that information presentation is adjusted to individual users, i.e., user models [33]. The systems that adapt the presentation of its features to the user model are called **adaptive hypermedia systems** [86, 87]. One of the essential stages in adaptive hypermedia systems is developing a model with a set of rules for adaptation [86]. This research proposed *extending the adaptation model with emotion-based rules for cancer website adaptation*.

Adaptive hypermedia technologies have been extensively researched [79, 80, 86-88]. Two main approaches are adaptive presentation and adaptive navigation support [33, 86]. The former focuses on content and text style adaptation [86]. Adaptive navigation, on the other hand, personalises the navigation aspects of the website, i.e., hyperlinks on web pages [89], and includes methods as: direct guidance, adaptive sorting, link hiding, link removal, link disabling and link annotation [89]. Figure 2.1 presents the **taxonomy of adaptive hypermedia technologies** by Brusilovsky [80]. Adaptive presentation was not applied to this research, while the *different methods for navigation support*, apart from map adaptation and link disabling, *have been used on the cancer website developed here*.

2.2.2 User profiling

User data collection is an essential stage in personalisation [90]. Data collection can be accomplished explicitly and implicitly, which is closely linked to the mentioned adaptability and adaptivity. *Explicit data* is obtained through a user's informed consent

[91]. It is collected through forms and questionnaires, what the user or someone else knows and perceives, and as such willingly provides [33]. The *implicit approach*, on the other hand, occurs without user awareness [91]. Implicit data is inferred from the tracked user activity on the Web [92] or behaviour monitoring [2], such as: websites visited, links clicked on, navigation behaviour or similar. *Personalisation on the cancer website developed for this research was based on both explicit* (personal data users provided on their profile pages, self-reports of emotions) *and implicit user data* (content clicked on and content ratings made) (see Chapter 5).

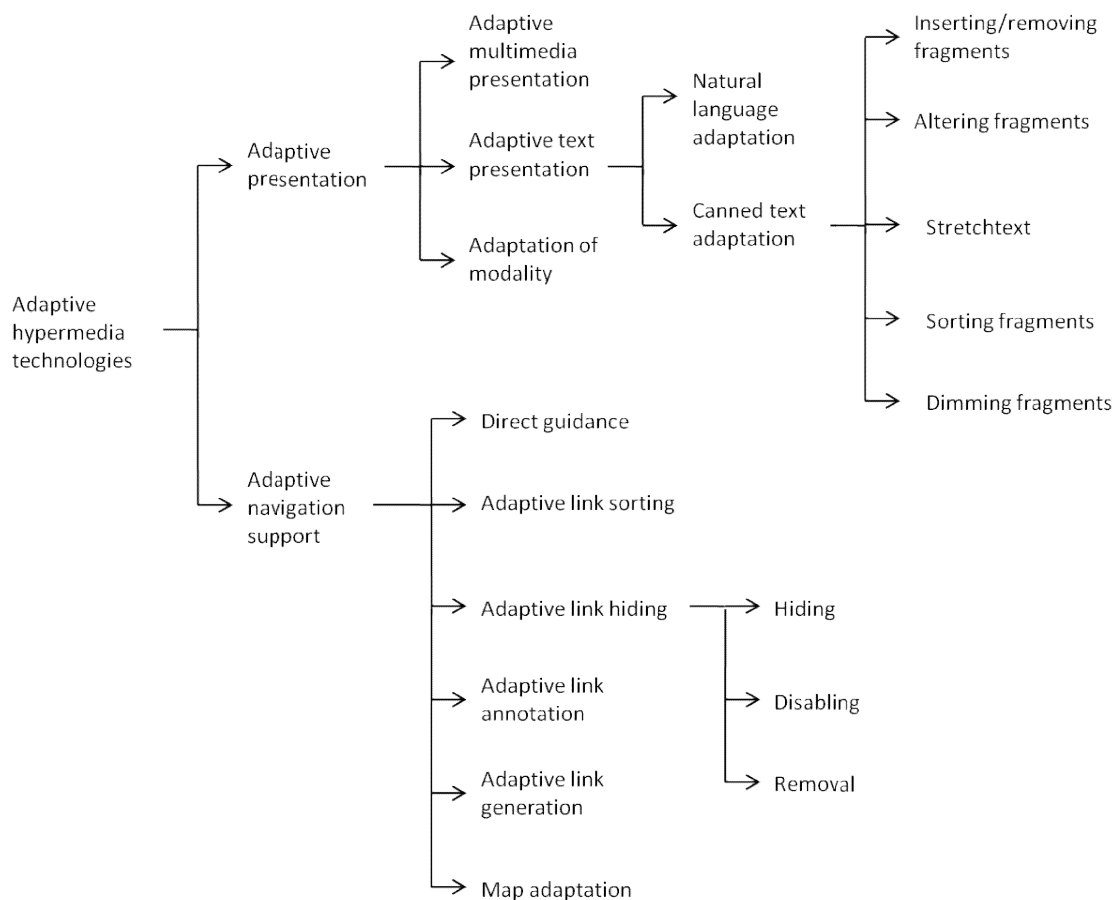


Figure 2.1. Taxonomy of adaptive hypermedia technologies, adopted from [80]

The collected user data serves to *segment user population into different profiles*, based on one or more of the following characteristics: demographic, socio-economic, psychographic, physical and psychological [33]. Germanakos et al. [33] argue that user

profiles based only on demographic and transactional model data, and factual and behavioural profile data, cannot be complete. A user profile without users' perceptual preferences is dubbed a '**traditional**' **user profile** [33]. The set of *traditional user characteristics* includes [33, 76]: knowledge, goals, background, experience, preferences, activities, demographic information, socio-economic information. Hence, they suggest *incorporating characteristics related to users' perceptual preferences*, which are factors that affect user's visual, mental and *emotional processes* [33].

Arguably, accounting for emotional processes in content personalisation could reduce anxiety and stress levels [33]. What thus results is a **comprehensive user profile** which combines the variety of user data [33]. Hence, personalisation technologies should take into account user psychological traits, including *emotions* [36]. It is, therefore, that this research sought to understand *whether emotions affect users' perception about and preference for personalisation on a cancer website* (Chapter 3 and 7), and to use these findings to *propose approaches for implementing emotion-based personalisation and adaptation to cancer websites* (Chapter 5).

2.3 Applications of online personalisation

2.3.1 Personalisation in online domains other than the health domain

Studies on applied personalisation predominantly include the following areas: education, entertainment, web browsing, e-commerce [77, 93, 94]. In a review of e-commerce personalisation studies published between 2000 and 2008, Adolphs and Winkelmann [93] found the following trends in this research area:

- More than half of the reviewed articles researched personalisation from the perspective of user behaviour and user perception about, e.g., trust, satisfaction, support, or expectations.
- 50% of the reviewed articles focused on recommender systems.

'Theoretical foundations' were, however, understudied [93]. These are the type of studies that focus on *identifying user needs and user groups to assist content providers in*

improving website adaptation. Identifying individual user needs – as are emotional needs, for a specific user group - people affected by cancer, led the research presented in this thesis.

Personalisation has been broadly adopted and studied *in e-commerce*. The majority of e-commerce websites claim they have adopted personalisation, at least in the basic sense [95]. More than 80% of them also report their personalisation efforts to be based on broad segmentation and clustering [95]. The websites and applications that are providing personalised experiences include some of the well known Web-based services, e.g.: Amazon, Facebook, LinkedIn, Bombfell (menswear), Stitch Fix (women's personal styling), Netflix (movies and television shows), Hulu (shows), Spotify (music), Pandora (music), and Advertising – Retargeted (Speak) and Interest-based [96].

Nevertheless, only a small fraction (10%) of retailers perceive to be highly effective in personalisation [95]. One third of retailers believe their means to support personalisation are limited or lacking [95]. The e-commerce domain can be considered a leader in the adoption of personalisation technologies, yet it shows room for improvement and further research. Understandably, therefore, *research on personalisation in other online domains is lacking, specifically the lagging health domain*, which is addressed in this thesis.

2.3.2 Personalisation of Web-based health services

Personalisation can be seen as an “asset” for health websites as it enables easier, more personal way for navigating the website, easier and faster access to more relevant content meeting personal health needs [57]. Studies show that *personalisation is one of the two most important usability and functionality factors determining users' preference for e-health websites* [11], and a decisive factor in selecting and trusting health websites [97-99]. Overall, online health users are interested in personalised health websites [100, 101].

However, the evaluation of 21 US hospital websites showed that personalisation adoption is lagging [23]. *The adoption of personalisation technologies in online health services continues to be slow and neglected* [27-30]. This is the case even with major health

portals [102]. One of the objectives of the research in this thesis was, therefore, to *introduce personalisation to a cancer website by implementing the features desired by the target users. Moreover, user acceptance and perceptions about the implemented personalisation services were thereafter explored.*

Normally, **personalisation in eHealth** implies *personalised treatments, interventions, medicines or learning material* [24-26]. The traditional approach to personalisation of eHealth has been to apply users' explicit feedback to deliver *educational material* matched to the collected preferences and health data, thereby aiming to affect health behaviour [103]. For example, personalised health systems have been used to educate patients to abide by a medical regime [104]. However, with the occurrence of Web 2.0 technologies, new opportunities for health application adaptation [103] arose with the widespread availability of user information, and a more common utilisation of Personal Health Records (PHRs). The application of personalisation in online health services has been so far in *PHRs, health education, search outcomes, and recommendations of clinical trials* [20].

There are some *health websites*, primarily US based, that *have introduced a limited level of personalisation* [20]. These are websites such as: TrialX [105], PatientsLikeMe [106], various Web-based PHRs, Healthy Harlem [107], WebMD [108], MedlinePlus [109] and EsTuDiabetes.org [110]. For example, WebMD, a US based but globally renowned health portal, collaborated with Wellpoint [111], and expanded to its services with personalisation based on member population segmentation [112, 113]. Other health websites incorporated [114]:

- content filtering and personalisation; for example:
 - Vadlo¹ – search engine for life sciences
 - Wellsphere² – offering online health information, primarily a community for health bloggers

¹ <http://vadlo.com/>

² <http://www.remedyhealthmedia.com/>

- GoPubMed³ – search engine for biomedical knowledge, based on GeneOntology used to retrieve PubMed publications sorted at the what, where, when, who levels
- websites with advanced search result manipulation and data filtering (e.g., MayoClinic.org⁴)
- and websites offering patient health record management (e.g., MayoClinic.org).

Other online health projects that experimented with personalisation include [103]: providing users with personalised health-related promotion messages (e.g., Riskbot); use of tags and ratings for personalised health education; and use of data collected from the major PHR's (Google and Microsoft) for health personalisation. Another interesting project is MyHealthEducator, which creates personalised recommendations of health information based on user data from the online PHRs [103]. The main problem with these personalised systems is that they rely on the existence and access to users' online PHRs and their integration [103] with existing applications.

In addition to the mentioned websites and applications, academic research has also been undertaken in online health personalisation. *Personalisation of health websites was studied from specific perspectives*, e.g.: identifying personalisation requirements of Dutch senior citizens [21]; introducing personalised educational material on stroke-precaution for elderly in Taiwan [115]; proposing Web-based personalised information and educational resources for cardiovascular diseases [25]; and, more recently, exploring the effect of personalised feedback on physical activities among adults from seven European countries [116].

Promoting healthier behaviour in patients with chronic conditions - for example neck and shoulder pain – was seen feasible with the use of Personal Coaching Systems (PCS) [117]. The PCSs provide personal feedback and employ machine learning to adapt the content. Another study used a kHealth system to aggregate asthma patient data from sensors and questionnaire responses, and claimed that using patient context to process the data, along with personalised medical knowledge, results in improved decision making

³ <http://www.gopubmed.com/web/gopubmed/>

⁴ <http://www.mayoclinic.org/>

[118]. Additionally, research applied to medical literature search (search engine for medical articles - TRIPDatabase.com) [119] indicated the effectiveness of personalised medical search results; they showed users prefer personalised rankings, in particular those related to the content viewed by other similar users [119].

Other research explored whether tailoring can predict health content elaboration (content clarification), specifically of educational health messages for adolescents [32]. The difference in scores for satisfaction and knowledge on the tailored and non-tailored website was not found. However, tailoring had a positive effect on content elaboration [32]. Nevertheless, additional research was suggested in order to understand whether the same applies to health content on websites other than the educational ones, and population groups of different attitudes [32]. Hence, the research presented in this thesis *investigated tailoring of a health website used by different categories of people affected by cancer*.

Only limited personalisation research has been applied to online cancer-related services, the area this research addressed. For example, an ontology-driven framework was proposed for providing personalised mHealth for young cancer survivors [120]. Another study [121] evaluated MijnAVL, an interactive non-personalised portal that provided educational material and other support to breast cancer survivors. The study implied that the portal's usefulness and efficacy could be improved by introducing feature tailoring [121].

Healthy.me [122] is a research platform that also provides tailored information for breast cancer survivors, specifically those in Australia. The platform focuses on offering personal health management, connecting with peers and health professionals, and cancer survivor care information. An evaluation study [122] of Healthy.me showed that users found such a system useful, however that it presented certain barriers to usage - such as technical errors and lack of content updates - as expected given that it is still a research e-health platform. In another study that evaluated the OncoKompas eHealth application that provides follow-up support to cancer survivors, including tailored feedback and

personalised advice, healthcare professionals highlighted the need to tailor care and to simplify the navigation [123].

Based on the reviewed literature, research on *personalisation in online cancer services is in exploration stages*. The **questions** that are **open** for research include: *conducting a systematic review of personalisation features that can be introduced to cancer websites, obtaining target user feedback about the potential personalisation services, and addressing the needs of cancer-affected populations from understudied, non-English speaking environments*. Another challenge in this area is that personalisation does not entail a one-size-fits-all solution applicable across different domains. It requires taking the unique set of target user characteristics into account. *Researching the specific characteristics of the cancer-affected users requires more attention, and is thus being addressed here* (Chapters 3).

2.4 User characteristics and emotions

Characteristics of online health users have been considered to a limited extent in the previous research. A US based study explored the effect of the understudied personal dispositions on the intention to disclose health information online [124]. They found that people who exhibit anxiousness, fearfulness and other *emotional instability* traits – and are thus more prone to negative emotions - are more sensitive about their health information [124]. They hence implied that *health website personalisation can be expanded to the less considered user characteristics*, as is personality [124].

Overall, a *deeper understanding of the comprehensive traits and needs of health users is lacking*. Moreover, lacking is the research on *how to employ the specific traits, states and needs of these users in generating personalised online health services*. Hence, the research presented in this thesis *looked into personalising and adapting cancer website content and features to the cancer-affected user characteristics*. It is further *argued here that one of the main characteristics of the cancer-affected population is their emotions*. The reviewed literature indicated that *adaptation to user emotions remains understudied* [125], and more so on cancer websites.

Research addressing IT acceptance, as well as online personalisation, has given some attention to user's cognitive processes and learning styles, however it has paid little attention to user emotions [125, 126]. On the other hand, it has been continually argued that *user emotions and moods should be taken into account in Web personalisation* [33]. This section defines emotions and discusses the application of user affects in computing. Additional review of emotion theories and the selection of emotions for this research is the subject of Chapter 3.

2.4.1 Emotions

Emotions are a driving force of human behaviour. Even though there is no commonly accepted definition [127], emotions can be considered as “*valenced reactions to events, agents, or objects*” [128]. An emotional process starts with perception and results in a comprehensive *response to a stimulus* [33], e.g. an object or, *in this research, a personalised cancer website and its elements*. However, emotions are not only reactions, they also strongly impact our experience and stimulate our actions [129]. Hence, other studies [51] and this research argue that *it is also necessary to understand the role emotions play in shaping user preferences and behavioural intentions*. These relations were modelled in the *conceptual framework* proposed by this research (Chapter 3).

While it is important to distinguish moods, feelings and other affective states from emotions [130, 131], researchers often use these terms interchangeably. According to the Tomkins' system [129] the classification of these terms starts with affect, followed by feeling, followed by emotion. *Affects* are the “innate, biological response to the increasing, decreasing or persistent intensity of neural firing” [129]. *Feeling* develops from awareness about an affect, and a feeling combined with memory of feelings results in an emotion [129]. *Emotions* are a “complex chain of loosely connected events that begins with a stimulus and includes feelings, psychological changes, impulses to action and specific, goal-directed behaviour” [127]. *Emotions begin quickly* [131], *have high-intensity, last shortly and decay over time* [130]. Moods, on the other hand, have low intensity [130], are of longer duration [132] (can last for hours to days) and even though

they are “highly saturated with one or another emotion”, they have different cause and physiology [131].

Emotions, it is thus argued, *are more appropriate to use in research involving capturing users' instantaneous reactions resulting from computer interactions* [54]. Therefore, the focus of this research are emotions. *This research seeks to understand the relation between emotions and the use of a personalised online health website.*

Several emotion-related, i.e., affective terms are used throughout this thesis, including: discrete emotions, positive emotions, negative emotions, positive (or negative) emotions mean intensity, aggregated affective state, and positively (or negatively) valenced aggregated affective state. Attempt was made to abide by the affective terminology which prevails in affective computing, personalisation and IT acceptance studies [49, 133-135]. In this thesis, the term *discrete emotion* (see Section 3.3.2) refers to a single discrete emotion category, for example joy or fear, which is measured by its intensity. Discrete emotions are classified into *positive* and *negative emotions*, based on their valence (see Section 3.3.2). These two categories of emotions are used in calculating the valence-based mean intensities (see Section 3.3.2). Hence, *positive emotions mean intensity* is the average intensity of all positive emotions a user reported in a specific moment or for a specific action. The same approach is applied to negative emotions in determining the *negative emotions mean intensity*. Another affective term used in this research is *(aggregated) affective state*, which indicates the overall affective state resulting from a combination of (positive and negative) emotions a person is experiencing (see Section 5.3.1.1). Finally, valence of the aggregated affective state is also considered (Section 5.3.1.1, Equation 5). If a person is experiencing positive emotions more intensely than negative emotions, such a state is labelled in this thesis as a *positively valenced aggregated affective state*. The opposite is true for prevalence of negative emotions, in which case the person is in a *negatively valenced aggregated affective state*. Otherwise, the *aggregated affective state* is *neutral*.

2.4.2 *Emotion taxonomies*

There are various, often disagreeing, **taxonomies of emotions** that describe and categorise emotions. The first to explore emotions with a scientific approach was Darwin [136]. Darwinian theory of emotion focused on identifying the universally recognised *facial expressions* of emotions [136]. Contemporary researchers have claimed the existence of universal expressions of, what are known as, **basic emotions**. The term ‘basic’ in basic emotions’ taxonomies is used to show that there is a number of discrete emotions which are separate and differ from each other in terms of appraisal, precursor events, response, physiology, and other features [137], and which are innate and common across cultures [136]. These emotions can also form more complex emotions in combining with each other [137]. Ekman [131], one of the pioneers in the *basic emotions* research, identified 13 basic emotions of which six – sadness, enjoyment, fear, anger, disgust, surprise - are the most frequently quoted [51].

The *cognitive approach*, which argues for emotions as a response to an event or object affecting the person [136], was first advocated by Arnold [138]. The Ortony, Clore, and Collins (OCC) theory [128] is also a cognitive theory; it accounts for the occurrence of emotions as a result of individual’s appraisal of the current context [128]. The *OCC model* [128] identifies 22 emotion types, among which are joy, fear, shame, gratitude, anger, love and hate [51].

There are other models that “treat emotions as fundamentally the same, differing only in terms of intensity or pleasantness” [137]. The popular models are Pleasure-Arousal-Dominance (PAD) [139] and Self-Assessment Manikin (SAM) [140] which measure three affective states: *pleasure*, *arousal* and *dominance* [130]. They are further explained in the next section.

The current trends in the emotions’ research point out the need to study larger sets of discrete emotions [54, 141]. Discrete emotions were found to better explain behavioural intentions. For example, the increased diffusion of certain content is not solely explained by the valence of emotions (positive vs. negative), but is more precisely explained by the impact of a specific discrete emotion [141].

Russell's framework [142] suggests a means to connect the different theories. Researchers argue that a *comprehensive list of emotions is obtained only by combining the various emotion taxonomies* [51]. *This approach was used in my thesis to establish a set of emotions commonly identified as basic* in the different classifications of emotions (Chapter 3). Moreover, guided by the arguments in previous studies [136, 143], this research explored not only discrete emotions, but also user affective states determined by aggregating emotions of the same valence.

2.4.3 Measuring emotions

In addition to the ambiguity of what emotions are compared to other affective states, another issue is how to capture and measure emotions. Research on emotion-aware recommender systems, has prompted the exploration of technologies for emotion recognition [81]. Various **methods** have been proposed in previous research. *This research used a subjective method*, the choice for which is next reasoned.

The methods used for affect detection each have their benefits and drawbacks [136]. The **objective methods** enable precise measurement of affective states, but are more complex. Generally, these methods monitor some aspect of person's *physiology*; for example: electroencephalograms – used to measure brain activity, electromyograms – measures muscle activity, electrodermal activity – measures electrical conductivity of sweat glands, electrocardiogram – tracks heart activity, and electrooculogram – follows eye movement [136, 144]. However, such methods require the use of special hardware (cameras and various physiological devices), and specific software with complex algorithms [43]. As a result, the main drawbacks of these techniques are: their cost and the burden placed on the user [145], invasiveness on users, restrictiveness in accessibility, requirement to use lab settings, and lower capabilities for discriminating between specific, equally valenced, emotions [54].

Other *psychophysiological* measures include automatic emotion recognition from speech [146], facial expressions [147] and body movement [148], or based on text or click stream analysis [145]. Affect detection from *voice* is non-invasive, time resolution wise is

fast, and is non-expensive [136]. However, *facial expressions* have higher accuracy rates compared to speech [136]. Using facial expressions to detect basic emotions is the most common method in affective computing [136]. Nevertheless, the drawback of facial expression recognition are the high costs, as this method requires trained human coders to perform manual classification of expressions [136]. *Sentiment analysis* or analysing text to extrapolate words that predict the writer's affective state is another method [136]. The disadvantage, however, is that sentiment analysis identifies the valence of a textual content, but not the discrete emotions [136].

Alternatives are **subjective methods** that are based on direct or indirect reporting of user emotions. The OCC cognitive theory identifies *self-reporting* as one of the methods to detect and collect emotions [136]. Manual emotion input via, e.g., surveys, questionnaires and self-reports, is used to explicitly gather user affective states [51, 81]. Research in affective neuroscience has questioned the use of self-reports for emotions [136]. It was implied that certain emotional occurrences impact behaviour, but are not necessarily conscious. Hence, using only self-reports for affect detection might result in missing out on those aspects of emotions that we are not consciously aware of [136]. Nevertheless, those findings were questioned and suggested to be applicable only to certain emotional stimuli [136].

The research in this thesis relied on a subjective method, i.e., user self-reporting, via a questionnaire, and an emotion measuring tool available on the PORT website (see Chapter 4 and 5). Self-reporting was selected as it was an accessible method, which was the least expensive, as well as the least demanding and intruding on the user, but directly requiring the user to reflect on their emotions.

The self-reporting method was frequently used in emotions' research [54, 149-152], but has not been applied to health website studies, to the best of my knowledge. This method was used for example in an e-learning study [54] where students stated how they felt about a computer game they played using an emotion-reporting dialog box with a scale ranging from 'very bad' to 'very good'. A similar method was used in a study that predicted user mood from keyboard and mouse interactions [43]. The mood rating

dialogue box presented the widely used and validated SAM instrument [140], which is explained towards the end of this section. In a different study, a Real-Time Subjective Emotionality Assessment (RTSEA) system was developed [152]. The RTSEA was based on self-reporting emotionality by selecting a point on the valence and arousal dimensions. Overall, the majority of studies presented pre- and/or post-usage questionnaires to collect user emotions [124, 141, 149, 151, 153].

There are a number of popular and *widely used validated tools for self-reporting* moods or emotions. One of these instruments is the Differential Emotions Scale (*DES*) [154]. Its original inventory consists of 10 discrete emotions (joy, surprise, anger, disgust, contempt, shame, guilt, fear, interest, and sadness) and for each emotion three subscales (i.e., question items) are reported on. However, since the here presented research explored a number of constructs, in addition to emotions, it would have been excessively demanding on a user to complete the DES in its original form.

Another method used in research connecting emotions and computer systems use is the *OCC theoretical model of affect* [128]. In one of the applications of this model, users were simply asked two questions – how they felt about the game they were playing, and how they felt about the pedagogical agent – and used a 5-point scale (from very bad to very good) to measure user affect [54]. Nevertheless, as previously explained, the OCC model comprises a large set of 22 emotion types, which rendered it too excessive, as was the case with the DES.

Alternatively, a popular model is the PAD model [139]. Developed by Mehrabian [139], it measures three states: *pleasure*, i.e., positivity or negativity of the affective state; *arousal*, indicating physical activity and mental alertness levels; and *dominance*, i.e., the extent of feeling in control [130]. A model which similarly uses the valence, arousal and dominance dimensions is the *SAM* [140, 155]. Each of the dimensions in SAM is rated on a 9-point Likert-based scale ranging between pleasant-unpleasant, aroused-unaroused and dominated-dominant, respectively. Figure 2.2 presents the SAM [140]. In one of the later studies of this research, the *SAM was incorporated into the emotion measuring instrument - Emotion Tool – developed for this research*. The results of the two

instruments were compared to test Emotion Tool’s reliability against the validated SAM. The study and the findings are further explained in Appendix A.

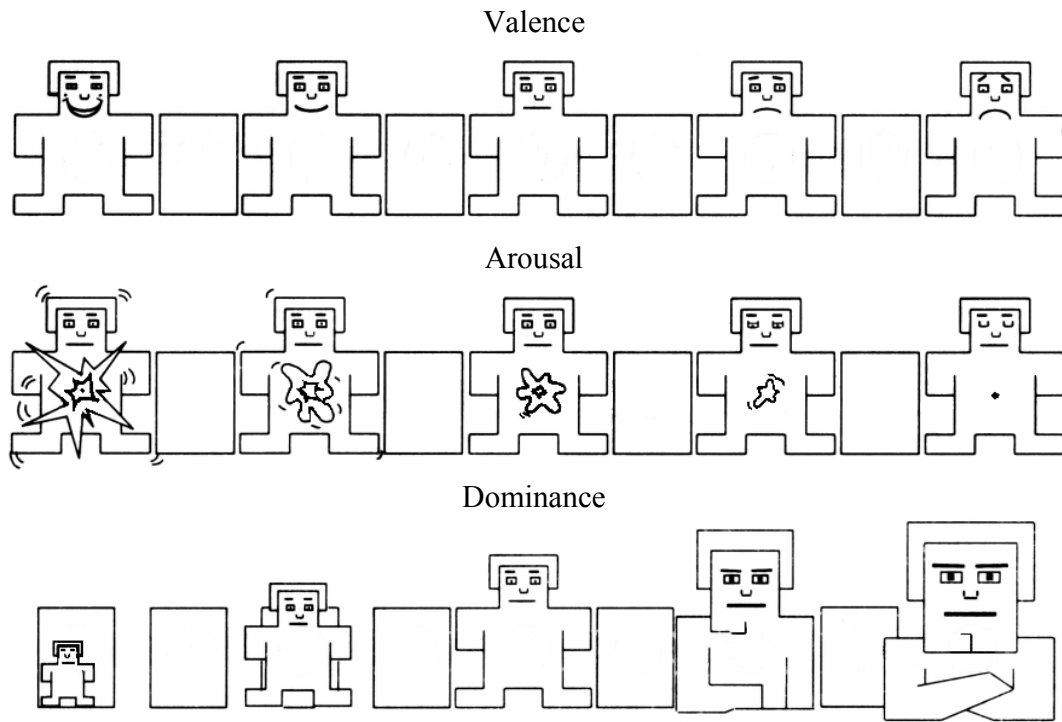


Figure 2.2. Self-Assessment Manikin⁵ presenting three affective dimensions – valence or pleasure (top), arousal (middle), and dominance (bottom)

There are several *disadvantages to the mentioned instruments*, due to which it was opted to *develop an emotion measuring instrument* for the purpose of this research and use on the PORT website. Some of mentioned instruments do not treat emotions as discrete categories, but instead aggregate emotions into broader affective states, such as valence or arousal. However, this research is also *interested in measuring and exploring the effect of each discrete emotion*, in addition to the effect of aggregated affective states. A greater limitation is that the mentioned instruments are proprietary material, accessible for research purposes, but restricted for others. The objective for this research was to *develop an emotion reporting instrument which would be available for public use on the cancer website built for this research, a tool which would be integrated with the rest of the system, and easily updated and adjusted to user requirements elicited from the evaluation*

⁵ Obtained with the permission of authors: [140, 155].

studies carried out here. The Emotion Tool was, thus, self-developed since it will be present on the PORT website, which is intended for commercial use, with real-life users.

An alternative option would have been to integrate into the system a *mood tracking application*, for example: Moodtrack Diary [156], T2 Mood Tracker (free) [157], Moodlytics (free) [158], or others. However, these applications *focus on moods and not on emotions*. They *do not cover all the discrete emotions* of interest for this research. Just as the mentioned emotion measuring instruments, some of *these applications are proprietary* and require purchase for use. Additionally, they are *mobile applications*, and the integration with the rest of the system could have presented barriers itself.

Interestingly, in evaluating the design of the mentioned mood tracking apps, the Emotion Tool developed for the PORT cancer website followed a similar principal. The PORT Emotion Tool has a simple interface; it lists the emotion words, and next to each is an emoticon of its most likely facial expression, as well as the intensity scale resembling a common 5-point Likert scale. Further explanation about the Emotion Tool is provided in Chapter 4 and Chapter 5.

2.5 Emotion sensitive systems

Scientific research on emotions was started in the 19th century with the works of Darwin [159] and James [160]. However, it is Turkle's and similar research in the 1980s that linked computers and emotions [161]. **Affective computing**, as it is called, has been particularly attended to in the recent time [46] with the attempts to improve HCI [43-45].

Studies in HCI have shown that *users perceive system's responsiveness to their emotions as useful* [162]. *Computer systems capable of recognising affective states* are able to respond to user's frustration and changeable mood by providing encouragement and comfort [43]. Such systems are, therefore, *perceived more natural, effective and usable* [43, 136]. This is specifically *important for the target population this research refers to, the cancer-affected people, who more likely experience negative emotions* [41] and whose *emotional health is damaged* [38, 39].

Affective computing research has, principally, worked on proposing *models for improved emotion recognition*, for example from facial expressions [135, 163]. Moreover, different algorithms - support vector machine (SVM), neural networks algorithm, namely Fuzzy c-means clustering (FNNs), classification algorithm, were evaluated and found as optimal solutions in recognising emotions including happiness, sadness, anger, fear, disgust, surprise, boredom, pain, and stress [44, 164, 165].

Nevertheless, emotion sensitive systems have also been applied to different areas including gaming [166], mental health, e-learning [136], as well as online advertising, e-commerce, affective-priming, etc. Whereby, the research mainly took two directions – firstly, it explored the *effect of computer system use on emotions*, and, secondly, the *influence of affective states on user behavioural intentions*.

Similar to the research presented in this thesis, a study on emotion recognition in *searching activities* [149] used six Ekman's basic emotions – sadness, happiness, anger, surprise, fear and disgust. *As in my research, they measured emotions at different points of system use*. Their findings indicated that emotions of a user change from the beginning to the end of the search process. Hence, in this thesis, it was also *hypothesised that a change in the intensity of emotions would result from interacting with a personalised cancer website* (Chapter 3). Successful search, based on the previous research, implied satisfaction; a user otherwise experiences anxiety or anger [149]. In HCI, therefore, as in other areas of life, *emotions stimulate us to certain actions, but also events and activities evoke emotions* [149]. I consequently studied in this thesis *whether the same was applicable to the population of cancer-affected people in interacting with personalised online cancer services*.

With respect to *emotions elicited in HCI*, particular focus so far has been on joy/satisfaction, anger and sadness [167]. In *e-commerce*, Ethier et al. [151] were the first to show that interaction with an online shopping website *induces six discrete emotions* - namely liking, joy, pride, dislike, frustration and fear. In *e-learning*, Sivaraman et al. [145] explored the emotions experienced at a specific point of system usage to instruct the learner towards the affective state which is the most favourable one for the learning

process [145]. Their system takes into account three affective states - happy, neutral and sad; whereby the goal is to bring the learner into the “neutral” state using emotional plugins and emotion modulators. Another e-learning study suggested that positively valenced affective state, if detected, should be maintained, as it leads to a positive experience with the system [54]. Furthermore, it was found that e-learning agent’s responses were perceived more useful when tailored to student’s affective state [162].

On the other hand, *emotions* also *influence technology usage*. Previous research has indicated relations between certain affective states, primarily anxiety and enjoyment (flow), and the use and acceptance of information technology [168-171]. Importantly for this research, previous studies showed that enjoyable state influences the use of the Web [172]. Furthermore, in *computer usage* research it was found that positive emotions improve typing speed, while negative emotions decrease it [173]. Research applied to *online advertising* showed that emotions influence users to share certain content more often than other [141, 174]. Positive emotions stimulate user’s engagement with content; inducing excitement and smiles in a user translates into sustainable engagement with the website [174].

The effect of emotions was also studied in *e-commerce*. Lu et al. [175] found that negative – specifically anger, feeling upset and feeling irritated - negatively influence customers’ repurchase intentions. Furthermore, *discrete emotions* were studied in relation to *website reuse intentions*. It was shown that *enjoyment* stimulates intentions to revisit a website [176], while *satisfaction* (measured by the level of satisfaction, pleasure, frustration, and delight) is the most important factor determining reuse intentions for online banking services [133].

Based on the reviewed literature, potential for further research was identified in the online health domain. Extracting the foundation from the previous studies, I propose in this research *that discrete emotions influence user interaction with the content and features of a personalised cancer website*. Moreover, *that the use of a personalised cancer website elicits discrete emotions* – nine different emotions studied here. Consequently, *the induced emotions influence user intentions to revisit the website*.

2.5.1 *Emotions in personalised systems*

There are *arguments for incorporating* real human characteristics, specifically personality and *emotions, to intelligent and adaptive system for an improved personalisation experience* [177, 178]. **Emotions in relation to personalised systems** were studied to an extent in online shopping [125], group decision support systems [130], e-commerce [33], online games [179], online entertainment [50], recommendation agents [51, 178], and personalised human-robot interactions [180]. For example, it was shown that emotional trust plays a role in the adoption of *online product-brokering recommendation agents*, whereby it is advised to include emotions in models for IT acceptance studies [126]. Consequently, one of the *main constituting factors of the conceptual framework proposed in this research are emotions* (Chapter 3). Furthermore, *mobile applications* for children with autism were studied that enable users to create multimedia files, capture emotions via facial expression recognition, and assign emotions to the media [181]. This is similar to the ‘Reactions’ button that *Facebook* has recently introduced, with which users can react to content with five emotions [47].

Overall, research connecting emotions and personalised systems can be categorised into two tracks. The first researches the *effect of personalised systems in eliciting emotions*, and *how the resulting emotions influence user behavioural intentions*. The second category explores *how emotions can be incorporated into user profiles* and used as a context in adaptation or in generating recommendations. The two tracks of research are next reviewed.

Some researchers advocated the *use of personalisation as a means to*, positively, effect the cognitive and *affective state of a user* [182]. They hence proposed the implementation of psychological customisation [182]. Other studies showed that personalisation in the form of *dynamic pricing* negatively reflected on user emotions [183]. Further research indicated that *personalising textual content* affected reader’s emotions and made the reader more interested and attentive to the presented content [184]. In *online shopping* studies [53, 125] it was suggested that a personalised experience evokes positive emotions in consumers, and that personalisation features and

positive emotions positively affect purchase intentions, while negative emotions negatively influence e-shopping behaviour [53].

Overall, previous research implies a positive effect of positive emotions (summarised in the happiness construct) and negative effect of negative emotions (anxiety) on personalised services and IT in general [125]. Hence, the research in this thesis *explored the influence of personalised services of a cancer website in evoking post-use emotions, and whether positive and negative post-use emotions have a different effect on intentions to reuse the personalised website* (Chapter 3 and Chapter 7).

One of the works that explored the ***effect of emotions on website content personalisation and adaptation*** was by Germanakos et al. [33]. They explored using the level of emotional processing (high, medium, low) as an implication for the type of adaptation to be applied to an e-learning system, specifically in the form of additional navigation support or adjustments to text font aesthetics. They further evaluated system performance and efficiency in two cases - content without any personalisation and adaptation, compared to adapted and personalised content. It was shown that taking into account the emotional process in personalising website content, anxiety and stress levels can be reduced [33].

Tailoring *online games* to user affective states by employing facial expression recognition was proposed in [179, 185]. An *online learning system with incorporated emotions* [185] collects two types of user data – feedback using a mouse and keyboard, and facial expressions recorded via a camera. An emotion recognition engine classifies the recorded facial expressions into affective states. Users give feedback by selecting emotions, which are compared to the emotions predicted by the engine. Finally, the learning materials are customised to the classified emotions.

Moreover, Conati et al. [54] in their probabilistic model of user affect for *e-learning games* collected user goals or personality to instantiate variables in the user model. They mined the system interaction data to correlate user goals and interaction behaviour. In future sessions affects towards the game and the agent were used to predict user's goals, which served to adapt game agents actions.

A similar approach was applied to the *website developed for this research*. Whereby, PORT website used the emotions reported at login to predict the features and content the user would prefer to have offered, and based on that determined the applicable adaptation – highlighting the preferred features, or hiding the disliked ones. However, unlike Conati et al. [54] who used machine learning models to predict user goals in real-time, this research used *hard-coded rules, triggered by emotions*, an approach adopted from [33], who also used mapping rules for adaptation. *On the PORT website, emotions trigger predefined rules that personalise content recommendations to user emotions*, interests and preferences, and also *adapt website features* to guide a user to those parts of the website potentially more preferred in a specific affective state (Chapter 5).

There is a recent interest in incorporating user **emotions in recommender systems** [51]. Hence, the development of affective recommender systems (ARS) that take into account emotions [186]. ARSs have shown to be effective in various domains [186]. A review of the state of the art in ARSs is of interest for this research given that one of the *main advancements proposed on the PORT cancer website are content recommendations personalised to user emotions* (Chapter 5).

The first to explore affective context in the recommender system domain were Gonzalez et al. [48] in 2007 [186]. According to them, user decisions are always accompanied by emotions. Hence, *user choice of content and features is also transmitted with their affective state* [48]. Thus, *emotions are essential for the recommendation process* [48].

Emotion-based recommender systems in general were studied by Tkalcic et al. [49]; they identified three stages of user-system interaction at which emotions should be detected, which are: entry, consumption and exit. In *music recommendations*, employing emotions for cross-domain item similarity was studied by Braunhofer, Kaminskas, & Ricci [52], who based the study on vocabulary of emotion-related tags. Zheng et al. [186] applied their research to *context-aware recommenders*. They observed “the role of emotions” in recommendations from two aspects: usefulness and effectiveness of emotions in improving recommendation performance; and the choice of emotion-related variables.

Studies on emotion-based *movie recommendations* started in 2009 [187]. A more recent study by [50] explored the concept of emotion-based user modelling for movie recommender systems and the *possibilities for expanding emotion-based recommendations into other areas*. They argued that emotions triggered while watching a movie can provide richer information for generating movie recommendations, compared to the ordinarily used ratings and preferences [50]. One of the methods they proposed for emotion recognition was *self-reporting via a dialogue box that appears while watching a movie* [188]; *similar to the emotion measuring instrument used in this research* (Chapter 4 and 5).

In *tourism*, the concept of “smart routing” was proposed [51]. A system based on “smart routing” would provide personalised recommendations for cultural tourism, and would take into account the effect of emotions on tourist's decision making process. Nine emotion categories, stemming from the Ekman's and OCC model's emotions, were considered: (joy, happy-for), (sadness, distress, disappointment), (satisfaction, gratification, relief), (hate, disgust), (admiration, hope), (surprise), (fear), (anger), and (pity) [51]. Six of the mentioned *states* - *joy, sadness, disgust, surprise, fear* and *anger* – are studied in my research, however *in relation to user perception about cancer website personalisation* (Chapter 3).

In *news recommendations*, emotion-based personalisation has also been considered [36]. An ontology-based approach was used in generated personalised recommendations of information by looking at, among others, the emotions evoked in a user by the content he/she viewed. Relatedly, Parizi and Kazemifard [189] suggested that generating news recommendations requires considering the feeling within the news article and the feeling that information elicits in a reader. Hence, a news recommender model was proposed that incorporates user preferences, however, instead of user emotions, they focused on the emotion of the news article. They argued for a positive correlation between the affect in the news and reader's mood, hence positive news would positively influence mood. Consequently, these arguments were used in *forming relations of the here proposed conceptual framework*, specifically those showing the *effect of website personalisation on evoking certain emotions in users* (Chapter 3).

As previously stated, emotions stimulate our actions and behaviour. It is, therefore, that emotions also determine our online behaviour – such as the use and consumption of items and services – in watching movies, choosing music to listen to, shopping, and other [188]. Hence, incorporating emotions into user models is not limited to movie, news, or tourism recommendations; emotion-based personalisation has broader research and application potentials [188]. Moreover, the *influence of emotions on user behaviour and use of health websites is understudied*. Additionally, *research on the stimulating effect of emotions in using cancer websites, and potentials of introducing emotion-based personalisation for online cancer content*, to the best of my knowledge, is *currently not available*. This research, therefore, *introduced a framework for exploring the influence of user emotions on the preference for cancer website personalisation* (Chapter 3) and *proposed rules for emotion-based personalisation and adaptation*, which were *implemented on the cancer website developed for this research* (Chapter 5) and were *evaluated by the target users* (Chapter 6 and Chapter 7).

2.5.2 Emotion-based personalisation in online health systems

While emotions were considered to an extent in certain online domains, *the application of emotion-based personalisation to cancer websites, especially adaptation to a comprehensive set of basic emotions*, to the best of my knowledge, *is currently not available*. The only related work that connects emotions and online health services is a US patent [190] that resulted in **MyCounterpane⁶ website**. The patent was published in 2016, more than two years after the start of this research.

MyCounterpane currently offers two communities: a community for illnesses (namely, *multiple sclerosis* and *mental health*), and a community for *veterans*. The website enables users to share personal stories, search for posts with a certain sentiment, search for other people with similar interests. Users are connected on the basis of similarity of their experiences, but also the emotions evoked by the experience.

⁶ <http://www.mycounterpane.com/>

The website offers a search tool – the Moodifier® - that accepts mood-related keywords and returns mood-matching information. Users can define how they feel at a particular moment by selecting the following mood options: sad, scared, angry, guilty, overwhelmed, stable, aware, determined, hopeful, happy and lonely. The search outcome panes that correspond the keyword moods are somehow distinguished (e.g. highlighted), otherwise they are shaded out or removed. Through the Moodifier Graph users can view each other's changes in affective state.

MyCounterpane includes elements relevant to this research, for example receiving indicators of user mood, distinguishing between mood-based search outcomes. However, *the fundamental approach is different*. Firstly, MyCounterpane focuses on user *moods*. Secondly, users submit a request for a community associated with a specific mood. Their method, hence, does not use emotions to automatically tailor content and features, but *uses moods as search terms to connect with others in a similar affective state or search for personal stories of others associated with a specific mood*.

The *PORT cancer website* developed for this research uses a similar approach, as it *takes the current emotions of a user and matches them to the last recorded emotions of other users* (subject of Chapter 5). However, unlike MyCounterpane, that either shows a list of users who feel the same and/or their posts, the *PORT website makes content recommendations*. Moreover, *similarity between users is not only determined based on emotions, but also user interests and demographics*. Furthermore, this is *only one parameter in generating content recommendations* on the PORT website. Additionally, *the PORT website includes other personalisation services which are not emotion-based*.

2.6 Identified gaps and contributions to the existing knowledge

The previous sections have reviewed the research that has been carried out in the related fields; particularly that relevant to emotion-based personalised systems and personalisation of health websites. This section identifies the **gaps in the current body of knowledge**. Thereafter, it states how my research contributed by addressing the **open questions**.

2.6.1 *Open questions in the related literature*

One of the *main questions* my research dealt with was *the level of personalisation that users of cancer websites prefer*. Based on the reviewed literature, some previous studies have explored introducing personalisation to health systems. For example, Myneni et al. [120] proposed an ontology-based framework for delivering personalised care information for young cancer survivors via mobile apps. Kuijpers et al. [121] proposed an interactive portal (various functions from educational to health record overviews) for breast cancer survivors, however without personalisation. And Milliken [190] developed a health-related system that employs mood to search for users or content of a matching mood.

While some of these systems are intended for cancer sufferers, *none of them encompass the broad cancer-affected population studied in my research – directly and indirectly affected users and those interested in cancer information*. Moreover, previous health research has either focused on systems that provide personalised messages, specifically for cancer survivors, or developing interactive system features. There is a *lack of research on cancer websites that have incorporated a comprehensive set of advanced personalisation features* that are available in other online domains (e.g., e-commerce or entertainment) or in more recent findings in adaptive Web-based systems. In other words, there is a *lack of research on health websites for cancer-affected users, which provide not only personalised content and information, but also other types of rich personalisation*. This type of personalisation has been implemented on the PORT website I designed for this research (further explained in Chapter 5).

Furthermore, the *environment* – language restrictions and healthcare services available – of the target users is also an important research consideration. The target users should be unbiased and unaffected by previous experience with health website personalisation. The health websites that offer certain personalisation features are US based or from developed European countries. The *existing literature on online health services, as well as online personalisation, has mainly focused on the Western developed countries*, in particular the US, UK, Netherlands, Finland, some other European countries, and China in a few cases. However, *research is lacking for environments where the target users have not been*

exposed to personalised eHealth, and have restricted access to cancer information due to language barriers. My research was, hence, firstly applied to people affected by cancer in B&H, an environment representative of the described issues, to which no studies in this field have so far been applied, to the best of my knowledge. Nevertheless, *to ensure broader applicability of the research results*, to cancer websites with global audience, efforts were made to *include worldwide participants* in evaluating the PORT cancer website. Target users from various countries were sampled, including those who have been exposed to personalised online services, as in the UK and the US.

Importantly, previous research has not looked into personalising online health services to user emotions. MyCounterpane [190] is a rare step in that direction, as it provides an online community for people suffering from chronic illnesses such as epilepsy, multiple sclerosis, lyme and mental health issues, to connect with others in a similar mood or obtain mood-matching information, i.e., mood-based support. Nevertheless, to the best of my knowledge, *there is currently no cancer website that incorporates emotions (discrete and aggregated) into user profiles for personalisation purposes*. Moreover, there are *no online health systems that provide emotion-based content recommendations and emotion-based adaptation*, as is proposed in this research.

Furthermore, there is a lack of studies on the user perspective about personalisation in online health services, particularly those establishing user preferences between personalised and non-personalised services. One of the rare studies was by Cortese et al. [32], who used a controlled experiment to explore adolescent user preferences for tailored or non-tailored health message elaboration. However, the website content they based their study on was not health specific, but rather focused on adolescent career goals. Moreover, no health-based study has evaluated user preferences for emotion-based personalisation. Hence, another set of open questions arises: *What are cancer website user preferences for personalisation? Moreover, can we use controlled experiments to establish whether such users prefer personalised services to non-personalised ones? Furthermore, could emotion-based personalisation be the preferred type of personalisation to be provided on a cancer website?*

Stemming from the above identified gaps is the *second main question* of my research. It delves into *whether emotions influence user perception and use of specific personalisation features on a cancer website, and how the emotion- and personalisation-related factors reflect on the intentions to reuse a personalised cancer website.*

The effect that emotions experienced after computer system use have on behavioural intentions has been researched to an extent. For example, the UTAUT2 model [169] incorporates hedonic motivation as one of the factors affecting behavioural intentions for IT. Yuan et al. [191] have applied the UTAUT2 model to the use of health and fitness apps. Pappas et al. [53] have shown that positive emotions increase purchase intentions in online shopping, while negative emotions have an opposite effect. Nevertheless, there is a *lack of research on the effect of a broader set of discrete emotions evoked post-use.* Moreover, there is a *lack of studies applied to cancer websites, and how post-use emotions reflect on user intentions to revisit and reuse a personalised cancer website.*

The effect of personalisation on user affective state has been researched to a limited extent in other online domains. Pappas et al. [53] have found that personalisation introduced to an online shopping site positively affects positive emotions, but does not reflect on negative emotions. Bourgonje [183] have also researched how dynamic pricing (personalising online prices) affects emotions. However, these were mainly applications in the e-commerce area. Furthermore, they provide a singular view of emotions, either in their aggregate states (e.g., based on valence), or focusing on very few singled out emotions. Hence, there is a lack of understanding how personalisation introduced to a cancer website reflects on the emotions of users of such systems. Moreover, there *is a need to establish which discrete emotions are affected – evoked, intensified or lessened – by cancer website personalisation services;* and how these emotions connect to website reuse intentions.

Additionally, the effect of pre-use emotions on user preference for individual personalisation features was used as the foundation for proposing emotion-based personalisation for cancer websites in this research. Previous research has explored the use of emotions in tailoring system agent's responses. Prendinger et al. [192] proposed an empathetic companion which recognises user affective state and adjusts the response of

an animated agent used in a virtual job interview. Conati and Maclaren [54] proposed a probabilistic model of user affect, which recognises user emotions during an e-learning based game and enables an intelligent agent to respond more effectively to the player's affective state.

Since 2007, *emotion-based recommender systems* have received significant attention; however, they have only been applied to a few areas. For example, Berkovsky [50] proposed using viewer emotions, captured while watching a movie, in generating future movie recommendations. Zheng et al. [186], Gonzales et al. [48], Arapakis et al. [187] proposed incorporating emotions with other contexts in filtering techniques for generating personalised recommendations.

Others have looked into how emotions can be used in adapting system appearance. Blom et al. [179] proposed identifying a player's affective state via facial expressions, and using these affects to tailor online game space in real-time. Kung-Keat and Ng [185] proposed a model for recognising emotions to adjust the design of an online learning system. Germanakos et al. [33] introduced a system that uses emotional processing (high, medium, low) as an implication how to adapt website aesthetics (font size and weight) and navigation support.

However, there is *no research that explored the effect of cancer website users' emotions on how they perceive individual website features and content*, and which they consequently choose to use and interact with. Thereby, *no current research has explored the applicability of emotion-based personalisation on cancer-related health websites*. Hence, no available research proposes approaches for adoption of emotion-based personalisation on cancer websites, as the previous research has mainly focused on e-learning and online entertainment. Moreover, there is a lack of research that encompasses emotion-based tailoring of both content and system appearance. While previous researchers have either used emotions in tailoring content recommendations or in adapting the design and navigation of the system, the open question is whether the two approaches can be combined within the same system. In other words, *can emotions users express at the start and during website use predict the content they would prefer* – and thereby be used for personalising content recommendations? But also, can pre- and

during-use emotions be *used for emotion-based adaptation*? Whereby emotions would trigger the adaptation of website navigation and presentation to guide users to the features and content they would prefer to interact with in such an affective state. The research in this thesis addresses the identified open questions.

Finally, while some studies on context-aware recommenders have researched the six basic emotions, the majority of studies on emotion-based personalisation have, however, focused on a single discrete emotion (e.g. anxiety) or their aggregate states (e.g., feeling good or bad). Nevertheless, *this thesis argues for the need to extend research to a broader set of discrete emotions*, however, also *not to neglect the affective states* resulting from aggregated emotions, as both can imply important personalisation patterns.

2.6.2 Contributions to the body of knowledge

This section highlights the main **contributions** of my research to the body of knowledge, which stem from the identified gaps in the reviewed literature.

- The primary contribution is the proposed *conceptual framework* for exploring *the effect of emotions on user perception about cancer website personalisation*, and consequently *their impact on intentions to reuse a cancer website* (Chapter 3 and Chapter 7).
- Secondly, the application and evaluation of *emotion-based personalisation to cancer website content and features* (Chapter 5 - Chapter 7).
 - This research, hence, *contributed* by establishing a *set of emotion-based rules for feature adaptation and content recommendations which are applicable to cancer websites* (Chapter 9).
- Thirdly, this research explored *the cancer-affected population's preferences for personalisation features* on cancer websites - *their preferences for availability of personalisation services, the approach to personalisation and the type of personalisation* (with or without emotion-based services) (Chapter 3 and Chapter 7).

- Moreover, it addressed the needs of a *cancer-affected population from an understudied environment* (see Chapter 1).

Consequently, a new perspective to cancer research was created, from the point of view of personalised online support for people affected by cancer. This research addressed the needs, preferences, characteristics of different profiles of the target users - people affected by cancer. As a result, this research showed a user-centric approach to the design and development of personalised cancer websites. One of the *main outcomes of this research was the personalised cancer website*. The PORT website was built from scratch, based on requirements identified by users; it incorporates emotion-based personalisation and adaptation techniques, and is currently publicly available in English and Bosnian.

2.7 Summary

This chapter reviewed the background and related literature, particularly focusing on the state-of-the-art in personalisation of online health services and detecting and using emotions for personalisation purposes. Research questions (Chapter 1 and Chapter 3) of this thesis have been drawn from the gaps and open questions in the reviewed literature. The next chapter presents the conceptual framework that I have devised for this research. It presents the underlying theories, including the affective and appraisal theories, theory of choice, and those addressing technology acceptance. It further presents the research sub-questions, research constructs and their corresponding hypotheses stemming from the framework.

Chapter 3

Conceptual framework: Underlying theories, research factors and hypotheses

This chapter proposes a conceptual framework (also referred to here as *research model*) for exploring emotions as factors (also referred to here as *research constructs*) influencing user perception of cancer website personalisation, as well as how the emotions- and personalisation-related factors affect reuse intentions for personalised cancer websites (RQ 2, RObj4). The following sections present the development of the framework from underlying theories and its evolvement through this research. The research questions are mapped to the studies that address them. Towards the end of the chapter, the research constructs are presented and linked to their hypothesised relations. This chapter represents my main theoretical contributions to the field.

3.1 Research questions and hypotheses

This research comprised *eight objectives, five studies and four website development phases* through which the *introduction and preference for emotion-based personalisation on cancer websites was evaluated (RQ 1)* and the *conceptual framework was developed and refined (RQ 2)*. Table 3.1 links the research objectives and the two main research questions to the studies and development phases in which they were addressed. The description of the objectives was provided in Chapter 1 (Table 1.1).

Table 3.2 shows a detailed mapping of (sub-)research questions (RQ) (rows) to the five studies (columns) carried out in this research. RQ 1 sub-questions are annotated with blue colour. RQ 2 sub-questions are organised around the research constructs (see Section 3.3), which are annotated with different colours. Purple is used for the construct *usefulness of personalisation features*, brown for the *usefulness of adaptivity and adaptability*, red for *satisfaction with personalisation*, grey for *usability*, green for *post-use emotions*, and orange for *reuse intentions*.

Table 3.1. Mapping research objectives to studies and phases of website development

RQ	Objective	Study/Phase	Period
RQ 1, RQ 2	RObj1	Study 1	April – May 2014
RQ 1	RObj2	Study 1	April – May 2014
RQ 1, RQ 2	RObj3	Phase I	July - September 2014
		Phase II	November 2014 - March 2015
		Phase III	October 2015 - March 2016
RQ 2	RObj4	Study 2 – Study 5	October 2014 – October 2016
RQ 1	RObj5	Study 2	October – November 2014
		Study 3	March - June 2015
		Study 4	March – April 2016
RQ 2	RObj6	Study 4	March – April 2016
		Study 5	September - October 2016
RQ 1	RObj7	Phase IV	May - September 2016
RQ 1	RObj8	Study 5	September - October 2016

The complete list of hypotheses of this research is presented in Appendix H. The same colour coding is used to show the research construct the hypothesis is associated with. Moreover, the hypotheses are annotated in such a way to associate them with the research question they address. For example, the *H 2.1.4 1* hypothesis is linked to the *RQ 2.1.4*, and it is the first (1) of the hypotheses for this RQ. Appendix H further highlights the study the specific hypothesis was tested in, and its result (partially/not/supported). Section 3.3 of this chapter presents the hypotheses in relation to the conceptual framework constructs, which are defined there.

As can be seen from Table 3.2, *certain research questions (and hypotheses) were addressed by a single study, while others were explored in several studies of this research* (see further explanation in sections 3.2.2 and 3.2.3 of this chapter). The main reason was that the *development and evaluation of the personalised PORT cancer website and the conceptual framework was carried out in phases*. Each phase introduced new personalisation features or new research constructs, as well as refined the existing ones; for example refinement of the emotion-based rules for adaptation, or the refinement of the instrument/questionnaire used to measure the research factors - e.g. usability and emotions. Thereby, the research questions were reapplied to the revised framework or the improved website.

Table 3.2. Research questions for Studies 1 to 5

Study 1	Study 2	Study 3	Study 4	Study 5
<i>RQ 1. Do people affected by cancer prefer to have emotion-based personalisation, generic personalisation, or no personalisation on a cancer website?</i>				
RQ 1.1. What is the state of the art in online cancer information seeking; specifically by people affected by cancer in B&H?				
RQ 1.2. What is the state of the art of <i>personalisation adoption</i> on web-based health services and specifically by online health service users in B&H, and the UK?	RQ 1.3. Do cancer website users prefer personalisation ? <i>Do users perceive a personalised cancer website more usable?</i>		RQ 1.4. Do cancer website users prefer emotion-based personalisation ?	
<i>RQ 2. Do emotions influence the perception about personalisation and intentions to reuse a personalised cancer website?</i>				
	RQ 2.1.1. Do users perceive personalisation features introduced to a cancer website as useful?			
	RQ 2.1.2. Do background characteristics influence user perception about the usefulness of personalisation features ?			
RQ 2.1.3. Do emotions affect cancer website users' behaviour? <i>Do emotions stimulate online health information seeking?</i>	RQ 2.1.4. Do emotions influence which <i>content</i> and <i>features</i> users will perceive useful , or choose to interact with on a personalised cancer website?			
		RQ 2.2. Do users of personalised cancer websites prefer adaptivity or adaptability ?		
		RQ 2.3. Which factors determine user satisfaction with website personalisation ?		
	RQ 2.4. Which factors influence how usable the website is perceived?			
	RQ 2.5. Does interaction with a personalised cancer website affect user emotions ?			
	RQ 2.6. Which factors determine reuse intentions for a personalised cancer website?			

Moreover, *user preference for the level of personalisation was essentially evaluated in two stages*. These coincide with first the introduction of generic personalisation to the PORT website in Phase I and II of website development (i.e., Study 2 and Study 3 evaluations), and thereafter the introduction of emotion-based personalisation in Phases III and IV, and the corresponding experiments carried out in Study 4 and 5 (see Chapter 5 for the explanation of the phases of website development).

3.2 Research propositions and conceptual framework

3.2.1 Underlying theories

The conceptual framework of this research was derived from three groups of theories relevant to emotions and use of personalised technology. The first group of theories focuses on emotions as stimuli of user behaviour, perception and preferences. The second group addresses the causes of emotions, and argues that emotions are reactions to events or objects. The third group focuses on user acceptance and use of technology. The theories are next presented.

3.2.1.1 Stimuli of user actions

The **first** group of theories argue that user motivation affects their view of system's personalisation and satisfaction with it [193]. They further help explain user information seeking behaviour and personalisation needs.

The information foraging theory [194, 195] was used to explain the search for online information by the cancer-affected population. Understanding user search behaviour is useful for HCI research aiming to improve interface design and website usability. In the context of this study, information foraging helps explain the demographic and affective characteristics that stimulate cancer-affected people to search for cancer information, the type of content and features they look for and (re)interact with, or why they move on to the next feature or even a website.

The *affect theory* [196, 197] defines emotions as drivers of human behaviour and actions [129]. It categorises emotions into positive and negative, and argues that the two categories influence attention and behaviour differently. Negative moods prioritise local information and detail [198], while positive emotions promote “global processing bias” [199]. Thus, cancer-affected people, who are more commonly in a negatively valenced aggregated affective state, are more inclined to pay attention to local details and tasks [199].

The *broaden-and-build theory* [200, 201] focuses on positive emotions. There are fewer positive emotions than negative ones, they are difficult to distinguish one from the other, and models for negative emotions are not able to explain them well [201]. The broaden-and-build theory argues for the positive effects of positive emotions, which are claimed to broaden attention and thinking, as well as willingness to explore and experiment with different activities. They overall broaden growth and development. Comparatively, in negative and neutral states people are incentivised to fewer actions [201]. Applied to this research – in positive states users are expected to want to experiment with and explore a cancer website, more than in neutral or negative states.

Thereby, the first proposition for the research model (Figure 3.1) is introduced. It comprises nine hypotheses answering RQ 2 - H 2.1.1 2, H 2.1.3 4, H 2.1.4 5a, H 2.1.4 5b, H 2.1.4 6a, H 2.1.4 6b, H 2.1.4 7, H 2.2 11a, H 2.2 11b (Appendix H) - and states that:

RP1. Emotions users come to the website with influence their perceptions about the website’s personalisation services, as well as choices and preferences for features and content to interact with.

3.2.1.2 Effect of personalisation on emotions

The **second** group of theories explain the source or the cause of emotions. The *appraisal* theories argue that emotions are reactions to stimuli coming from objects or events that a person comes in contact with [136]. The *Cognitive structure of emotions theory* [128] accounts for the occurrence of emotions as a result of individual’s assessment of the

current context [128]. The *Roseman's appraisal theory* [202] claims emotions result from a combination of cognitive appraisals. These theories distinguish between positive and negative emotions [202], which result from an event being considered as consistent or inconsistent [203] (respectively) with the goal of individual's actions [151].

Consequently, the second proposition (RP2) is devised, and incorporated into the framework (Figure 3.1) through the hypotheses: H 2.5 17a, H 2.5 17b, H 2.5 18a, H 2.5 18b, H 2.5 19a, H 2.5 19b (Appendix H). P2 looks into the effect of interaction with a personalised cancer website on the post-use aggregated affective state as:

RP2. Users' appraisal of the cancer website's personalised services – i.e., usefulness of the personalisation, satisfaction with the personalisation and usability of the website - induce emotions in a user after completing the interaction with the website.

3.2.1.3 Choice to use a personalised website

The **third** group of theories incorporates aspects of acceptance and use of technology. The *principle of least effort* theory [204] states that online users are willing to accept information of lower quality or quantity, if that enabled them to minimise the level of effort needed to obtain the information. This theory has been used to empirically test a model for personalised content recommendations [193]. Based on this theory it can be argued that providing personalised content and features that are more relevant for the user, and as such are useful in reducing their effort, could positively reflect on user satisfaction.

The *UTAUT2* [169] is an extension to the *unified theory of acceptance and use of technology (UTAUT)*. The attractiveness of the UTAUT model is that it unifies the constructs of other renowned models (including, technology acceptance model [205, 206], theory of planned behaviour [207], diffusion of innovations [208], and other) and identifies further factors that influence user acceptance and use of information technology. Together, these factors explain more than 70% of variance in behavioural intentions. Moreover, UTAUT and UTAUT2 models were tested in different contexts

and used in the related research (e.g., adoption of health apps and social recommender systems) [191, 209-212].

UTAUT2 (published in 2012) was selected for this research as a more recent perspective, due to the spread and use of the more novel technologies, as are personalised online systems. Importantly, UTAUT2 proposed a construct - *hedonic motivation* (i.e., the experience of fun, enjoyment and entertainment) – which is closely linked to the here-studied user affective states, and which was shown to directly influence behavioural intentions. This research adopted several UTAUT2 constructs to explain the intentions to use a cancer website. These are: *performance expectancy* - adapted in the form of *usefulness of personalisation features* and *satisfaction with website personalisation*; *effort expectancy* – adapted here as *website usability*; *hedonic motivation* – which was explored here as *emotions* (specifically post-use emotions); and *behavioural intent* – studied here as *reuse intentions*.

Rational choice theory [213, 214] further clarifies the decision making process. The utility theory, an underpinning concept in the choice theory, has been successfully applied in research models studying personalisation in online marketing [83], and online health information disclosure [124]. An individual makes a choice from a set of alternatives based on their preferences and available information. The research in this thesis, thus, postulates that a user affected by cancer will use their beliefs and values (stemming from their background, interests, preferences and their affective state) to decide between receiving or not receiving personalisation, as well as whether or not to reuse the website.

However, the above theories do not explain well the role of emotions in the process of system interaction or in forming subsequent behavioural intentions. Therefore, this research also incorporated elements from the ***affect theory of social exchange*** [215]. This theory was used in research on exchange of personal information for online personalised services [83]. In order to obtain website personalisation, users exchange their demographic data, interests, preferences and affective state. Obtaining personalised services motivates users to disclose their information [83]. The propositions of *social*

exchange [216] and *affect theory* are applicable to this research – it is postulated here that an exchange of data for personalised services on a cancer website and the interaction with the personalised website itself would evoke (both positive and negative) emotions in users. As users repeat actions they reward them [216] and strive to perform and repeat activities that maximise positive affects and reduce the negative ones [129], it can be inferred that users will be stimulated to revisit the website when personalisation and website interaction evoke positive emotions.

Stemming from the theories that explain the intentions to use a specific technology is the third proposition of this research. It is reflected in the conceptual framework (Figure 3.1) by the following hypotheses – H 2.6 21, H 2.6 22, H 2.6 23a, H 2.6 23b (Appendix H), and argues that:

RP3. The intention to reuse a personalised cancer website is affected by users' appraisal of the personalised services – their usability and user satisfaction with them. Moreover, the decision to reuse the website is directly influenced by the emotions the website interaction evoked.

Figure 3.1 (Section 3.2.3) shows the final research model comprising the three propositions and showing the relations between the researched constructs.

3.2.2 Conceptual framework development

The conceptual framework evolved through four studies (studies 2-5) of this research. *Study 1* focused on identifying the state of the art in the use of personalised online health services, primarily in B&H, but also in the UK. Given that the PORT website has not been developed and hence not evaluated at that stage, Study 1 did not test the research model. Instead, it served to review the state-of-the-art in this area, from which the requirements for the website development and the subsequent study were devised.

The first version of the research model was proposed in *Study 2*. It comprised five factors that were included in the final framework, which are: user background, emotions pre- and post-use, usefulness of personalisation features, usability and reuse intentions. The

construct satisfaction with personalisation was not introduced at that stage. Furthermore, specifically for this study, the *usability* construct compared the personalised PORT website and the original, non-personalised, PORT website, while all the subsequent studies exclusively evaluated the usability of the various versions of the PORT website developed within this research.

The intermediate research model in *Study 3* included all the factors found in the final framework – user background, emotions pre- and post-use, usefulness of personalisation features, satisfaction with personalisation and reuse intentions. A unique construct explored at this stage was *preference for adaptivity vs. adaptability*, which was substituted with the factors *usefulness of adaptivity* and *usefulness of adaptability*. The *preference for adaptivity vs. adaptability* factor measured whether users preferred the website to perform the tailoring automatically (adaptivity) or to be enabled to manually customise the website themselves (adaptability). The detailed items of the construct are presented in Appendix B. This construct specifically focused on what a user preferred as an approach to personalisation, irrespective of the approach that was applied to the website itself. The factors it was substituted with - *usefulness of adaptivity* and *adaptability* - evaluated user perception about adaptive or adaptable services after having a chance to interact with them on the personalised PORT website. Additionally, the factor *usefulness of personalisation features* evaluated an extended set of personalisation features that were introduced to the PORT website in Phase II of development (from 24 to 33 features). There were also changes to the set of discrete emotions measured for the *pre-* and *post-use emotions* factors (see Table 3.4).

3.2.3 Final conceptual framework

The **final conceptual framework** of this research is illustrated in Figure 3.1. This framework was the basis for Study 4 (certain relations were followed up also in Study 5). The final framework explored nine *discrete emotions* for the *pre-* and *post-use emotions* factors. It included four types of *user background* characteristics: age, gender, country of residence and cancer-effect.

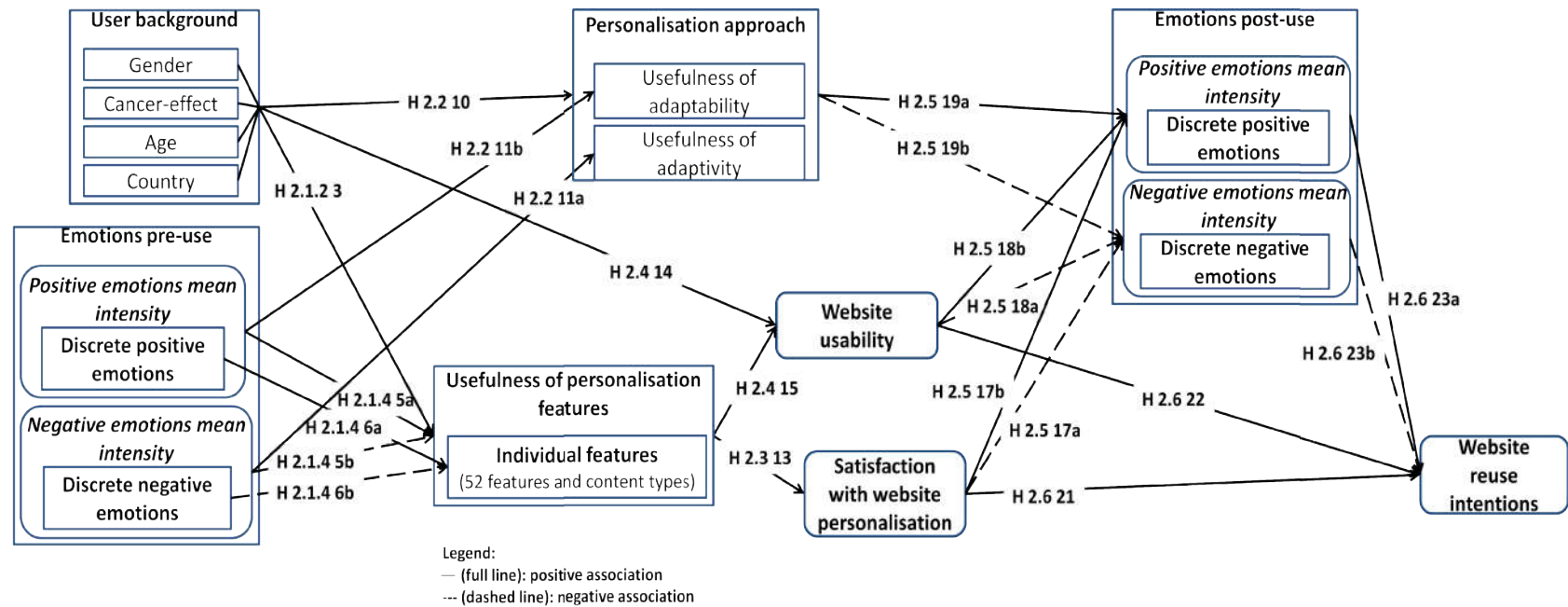


Figure 3.1. Research model

The *usefulness of personalisation features* was measured by 32 features implemented on the PORT website in Phase III of development (in Study 5 an extended list of 42 features of the latest PORT website version was used for this factor). The approach to personalisation was studied via two separate factors – *usefulness of adaptivity* and *usefulness of adaptability* – which measured the usefulness of PORT website’s adaptive services, and separately the usefulness of its adaptable services (further explained in Chapter 7, Section 7.1.2). The final framework further incorporates the three factors explored in the earlier versions of the conceptual framework, specifically *satisfaction with personalisation*, *website usability* and *reuse intentions*.

The research model implies that user perception of the usefulness of the personalisation services they encounter and interact with on a cancer website (*usefulness of personalisation features*, *usefulness of adaptability* and *adaptivity*), depends on the *background* characteristics, as well as the *affective state* they were in when they came to the website. In turn, users’ view of the *usefulness* of the website’s *personalisation features* influences their perception of the *usability* of the website and the level of *satisfaction* with the personalised website. In the end, the *intentions to revisit and reuse* the personalised cancer website are influenced by the *emotions* evoked by the use of the website. Hence, the *post-use emotions* are affected by the usefulness of the website’s approach to personalisation, website’s usability and user satisfaction with the website. The latter two factors also directly determine the intentions to reuse the website.

Table 3.3 lists all the constructs the final research model comprises, summarising their labels, definitions and sources they were adopted from. The following section presents the individual research factors and the hypotheses that address them.

3.3 Research constructs

The research constructs are explained in the next sections (Section 3.3.1 to 3.3.8) linking them to the hypothesised relations. A detailed overview of the questionnaire items and scales used to measure each of the constructs across the five studies is given in the Appendix B.

Table 3.3. Research model constructs (factors)

Construct	Definition	Source
<i>User background</i>	User characteristics determined by their age, gender, country of residence, and how cancer has affected them*.	Commonly used measures; *items based on classifications from [217].
<i>Emotions pre-use and emotions post-use</i>	Intensity of 9 basic emotions before starting to use the website / after using the website.	Self-developed; scale and question type adopted from [149, 151], emotions' classification primarily based on the works of [127, 131, 218].
<i>Usefulness of personalisation features</i>	User perception about the usefulness of individual personalisation features they interacted with on the PORT website.	Self-developed; construct label adopted from [205]; scale and question type adapted from <i>website interface design</i> [151] and <i>usefulness of multifaceted OSLM features</i> [219].
<i>Usefulness of adaptivity</i>	Measures user perception about the usefulness of all PORT website's adaptive services/features.	Self-developed
<i>Usefulness of adaptability</i>	Measures user perception about the usefulness of all PORT website's adaptable services/features.	Self-developed
<i>Website usability</i>	Perceived usability of the website, measured by the 10 items of the established SUS system usability instrument.	SUS items [220]
<i>Satisfaction with website personalisation</i>	Satisfaction level with the website's services related to personalisation, including content relevance and matching to user interests and emotions.	Construct items were adapted from: <i>personalisation quality</i> [221], <i>perceived personalisation</i> [126], <i>satisfaction</i> and <i>usefulness</i> [222], <i>site quality</i> [223], <i>personalisation</i> [83], <i>motivation</i> [219], and adjusted to address personalisation on a cancer website.
<i>Website reuse intentions</i>	Measures intentions to visit and use the website again.	Construct items adopted from: <i>intention to purchase</i> [83, 125], <i>behavioural intentions</i> [90]; construct label adapted from: <i>likelihood of usage</i> [221], <i>intention to adopt</i> [126].

3.3.1 *User background*

The *user background* factor encompasses the user characteristics of: *age, gender and country of residence*. Additionally, a self-developed item - *how cancer affected a person's life* - categorised cancer-affected people into:

- i. directly affected by cancer, i.e., cancer patient
- ii. indirectly affected by cancer, i.e., having a family member/friend suffering from cancer
- iii. being a caregiver to cancer patients
- iv. not directly or indirectly affected by cancer, but interested in informing oneself about cancer
- v. or not belonging to any of the above groups.

User demographic characteristics (e.g., age, gender, education level) have been commonly included as control variables in other research related to online health [64]. User demographics were also used as research model constructs, for example in a study on willingness to be profiled online for personalised advertising [224].

Previous research focused on cancer patients, who were found to be more likely to use online health resources [64]. Nevertheless, statistical reports also indicate that more than half of the users of online health information are the indirectly affected population [217]. Hence, this research hypothesised the effect of the four user background variables (age, gender, country, cancer-effect) on user perception about cancer website services (refer to the hypotheses in sections 3.3.3 and 3.3.4). Particular focus was on establishing whether there is a difference in users' behaviour depending on how cancer has affected them.

3.3.2 *Emotions (pre- and post-use)*

The research model proposed in this thesis includes emotion-related constructs. These are categorised into *pre-* and *post-use emotions*. The *pre-use emotions* factors measure the extent to which emotions are felt before starting to interact with a cancer website, while the *post-use emotions* factors look at the emotions felt after website interaction. Both pre-

and post-use emotions are explored as discrete emotions, as well as aggregated affective states via two factors – *positive emotions mean intensity* and *negative emotions mean intensity*.

In the final research model, nine emotions were used to measure the pre- and post-use emotions constructs. The selection of discrete emotions was elicited from the basic emotions' taxonomies. Throughout the five studies performed for this research, there have been changes to the set of emotions explored (see Table 3.4). Hence, the first three studies explored a larger set of emotions. The first and second study focused exclusively on Ekman's [131] taxonomy and incorporated the 13 basic and possible basic emotions. In the third study, in addition to the Ekman's list, other classifications were considered, which resulted in a different set of 12 emotions. However, in the last two studies, some of these emotions were discarded to devise a more focused set of the commonly identified basic emotions.

It was argued that a comprehensive list of emotions is only obtained by combining multiple emotion taxonomies [51]. Hence, in Study 4 and 5, several taxonomies advocated by Ekman [131], Plutchik [127], Tomkins [196], Izard [218], as well as other emotion theories (e.g. OCC theory [128]), were compiled to obtain a comprehensive list of the *most commonly identified basic emotions*. Consequently, the *final research model* (Figure 3.1) *explored the following nine basic emotions*:

- *Joy* (also referred to as enjoyment or happiness) [37, 127, 129, 131, 154, 225];
- *Interest* [37, 131, 154, 197, 226], as a higher level of anticipation in [127];
- *Surprise* [127, 129, 131, 154];
- *Fear* [37, 127, 129, 131, 154, 225, 227];
- *Sadness* [127, 131, 154, 228], as distress in [225], as anguish-distress affect in [129];
- *Shame* [131], as shame-humiliation affect in [129, 154];
- *Guilt* [131, 154];
- *Anger* [127, 131, 154], as anger-rage affect in [129];
- *Disgust* [127, 131, 154], as disgust affect in [129].

In addition to the nine emotions listed above, other emotions researched in studies 1-3 include:

- *Excitement*, a basic emotion [131], viewed as interest-excitement affect according to [129], and intense interest according to [154].
- *Embarrassment*, also a basic emotion [131], or reported as shame-humiliation affect in [129, 154].
- *Awe*, was considered a basic emotion [131], as well as a combination of surprise, distraction and fear/apprehension according to [127].
- *Contempt* was classified as a basic emotion by several taxonomies [131, 154].
- *Boredom* - disgust and boredom are different intensities on the same primary emotion dimension, according to [127].
- *Calmness* – was mentioned as serenity in [127], tranquillity in [139], and as calm on the arousal dimension in [140].
- *Anxiety* - observed as a level of fear in [229], included in the PAD Model [139].

Table 3.4. Researched emotions and intensities

Study 1 (1-5: most likely – most unlikely)	Study 2 (0-10: not at all – extremely)	Study 3 (1-5: not at all - extremely)	Study 4 (1-5: not at all - extremely)	Study 5 (0-4: not at all - extremely)
Fear	Fear	Fear	Fear	Fear
Interest	Interest	Interest	Interest	Interest
Sadness	Sadness	Sadness	Sadness	Sadness
Surprise	Surprise	Surprise	Surprise	Surprise
Happiness	Happiness	Happiness	Joy	Joy
Guilt	Guilt	Guilt	Guilt	Guilt
Disgust	Disgust		Disgust	Disgust
Shame	Shame		Shame	Shame
Anger	Anger		Anger	Anger
Awe	Awe	Awe		
Embarrassment	Embarrassment	Embarrassment		
	Excitement	Excitement		
Contempt	Contempt			
Enjoyment				
		Anxiety		
		Boredom		
		Calmness		

Furthermore, a *distinguishing feature of this research* is that it *looks both at discrete emotions, as well as at the higher, aggregated level, at a user's general affective state*. This approach was taken in order to account for the criticism in using discrete emotions only [136, 143], which is particularly relevant for research outside the social context, such as affective computing [136].

Hence, the emotions studied here were further categorised into positive and negative, based on the classifications in [37, 151, 174, 230-232] as follows:

- *negative emotions*: fear, anger, disgust, sadness, shame, guilt
- *positive emotions*: interest, joy.
- *surprise* was classified as a neutral emotion in some studies [129, 137]. Thereby, to account for its ambiguous valence, in this research surprise was classified as a *positive emotion* in Studies 2 and 3, *and as a negative emotion* in the last two studies, based on the findings of exploratory factor analysis (see Chapter 7, Section 7.1.1).

The two valence-based categories of emotions were used to determine two valence-based affective states - the *mean intensity of all positive emotions* (i.e., *positive emotions mean intensity*), and *mean intensity of the negative emotions* – which are aggregated by the system. Equation 1 shows how $AIE(v)$ - the average intensity of emotions of positive or negative valence v - is calculated. Whereby, $NE_v = \#Ei$ is the number of reported emotions of that valence; $I_v(Ei)$ is the intensity of emotion i ; v is the valence of the emotion (positive or negative). For example, the *positive emotions mean intensity* ($AIE(positive)$) would be the sum of intensities the user reported for *interest* and *joy*, divided by the number of positive emotions the user reported, which could be two or less. The *negative emotions mean intensity* ($AIE(negative)$) is calculated in the same way, however applied to the above stated negative emotions.

$$AIE(v) = \frac{\sum_{i=1}^{NE_v} I_v(Ei)}{NE_v} \quad (1)$$

Emotions in previous research: The previous chapter (Section 2.6) reviewed research on the effect of emotions on user behaviour in different online contexts, as well as the

affective responses to online stimuli. For example, studies show that personalisation of an e-shopping website positively influences positive emotions [53]. Similarly, in this research, *the effect of personalisation on emotions experienced after using a cancer website was explored*, as hypothesised in Section 3.3.7.

Previous studies' findings also indicate that positive emotions increase online purchasing intentions, while negative emotions have an opposite effect [53, 125]. Hence, this research looked into the *influence of post-use emotions on reuse intentions of a personalised cancer website*, as shown by the hypotheses in Section 3.3.8.

Some previous research has studied discrete emotions in relation to technology use. The effect of boredom was analysed in e-learning studies [233], emotion recognition in HCI [44], and studies measuring emotion [139, 140]. Anxiety was explored in studies on the effects of emotions on computer systems use [125, 149, 165]. Ethier et al. [151] studied how online shopping experience influences six emotions – liking, joy, pride, dislike, frustration and fear. Blom et al. [179] researched facial expression recognition of six basic emotions - happy, surprised, angry, disgusted, afraid, sad, and neutral state, that can be used in personalising computer games. However, the research in this thesis *comprises a broader set of basic emotions commonly identified in several emotion taxonomies*. The review of literature further showed that studies of comprehensive sets of discrete emotions are still lacking, moreover, studies exploring the use of these discrete emotions for emotion-based personalisation of cancer websites are lacking.

Hence, distinguishably, this research also explored the understudied *influence of user emotions at the start of website use on their preferences, choices of which features to interact with, and overall the perception of usefulness of the personalisation offered by the website*. In addition to the hypotheses presented in the next section, this research hypothesised that discrete emotions (pre- and during use) can serve as a basis for personalisation, to predict the use of specific website features, as follows:

H 2.1.4 7. *Emotions users feel at the start and during website use can predict which content and features they will interact with.*

3.3.3 *Usefulness of personalisation features*

The factor *usefulness of personalisation features* was self-developed. It measures how useful a user perceived each of the individual personalisation features implemented on the PORT cancer website, after having interacted with them. Items from the popularly used *perceived usefulness* instrument [205] were adopted for this factor. Nevertheless, the *usefulness* construct in my research *evaluated the website's individual personalisation features*. Such detailed evaluations of usefulness of individual system features have been applied in e-commerce studies [151], and social personalised adaptive e-learning [219].

Previous research findings: The literature review showed that some level of personalisation was applied to health websites. However, mostly it has been applied ad-hoc, non-systematically, not involving the target users in selecting what they consider to be useful personalisation features. A recent study indicated that users of e-health websites prefer personalised information [11]; website navigation [234] - quickly finding relevant information via menus, graphical elements, logical and memorable layout [11]. On the other hand, users who are familiar with different technologies do not give much importance to ease of use and learnability [11]. Thus, this research, firstly, *introduced a comprehensive set of personalisation features to the PORT cancer website*. Secondly, users were asked to *evaluate the usefulness of each of the features*, after having a chance to experience them on the cancer website.

Usefulness is an essential factor for system acceptance [235] and reuse [57]. Information technology has been commonly evaluated for its usability [11, 220], acceptance, ease of use, and usefulness [205]. However, this research aimed at addressing an underexplored topic - the *usefulness of the personalisation introduced to a cancer website*, and hypothesised that:

H 2.1.1 1. *People affected by cancer perceive personalisation features they are offered on a cancer website as useful.*

H 2.1.1 2. *Personalisation features recommended to users based on their emotions are the features users rated the highest in terms of usefulness.*

Moreover, this research sought to understand the influence of users' characteristics – specifically background and emotions – on their perception of website features and content, as proposed under the *first research proposition*. The aim was to *identify those characteristics that predict the like or dislike of specific features*, and hence *can be used in user profiling, i.e., in devising emotion-based personalisation*. Therefore, the following was hypothesised:

H 2.1.2 3. *User background characteristics influence the perception about the usefulness of personalisation features.*

H 2.1.4 5a. *Overall intensity of pre-use positive emotions positively affects the perceived usefulness of personalisation features.*

H 2.1.4 5b. *Overall intensity of pre-use negative emotions negatively affects the perceived usefulness of personalisation features.*

H 2.1.4 6a. *Discrete pre-use positive emotions positively influence how useful each individual personalisation feature is perceived.*

H 2.1.4 6b. *Discrete pre-use negative emotions negatively influence how useful each individual personalisation feature is perceived.*

3.3.4 Usefulness of adaptivity and Usefulness of adaptability

The two factors ***usefulness of adaptivity*** and ***usefulness of adaptability*** measured user perception of usefulness of adaptive and adaptable features that were incorporated into the PORT cancer website. The items of the adaptivity-related factor corresponded to the features that perform automatic tailoring and, on the other hand, the adaptability-related factor comprises services that require user involvement. The complete set of services comprising these two factors is provided in Chapter 7 (Section 7.1.2).

Previous research findings: There are various studies in other research areas [84] that have investigated how and whether to distribute the control process between the user and

the system. Some indicate that adaptive systems are better accepted [82], others point towards benefits of semi-adaptive system that balance the two approaches [84], while other studies show that enabling users to have control, diminishes negative effects [85]. Hence, to *understand which approach to personalisation is perceived useful on a cancer website*, the research in this thesis hypothesised that:

H 2.2 8. *Users of personalised cancer websites prefer adaptability over adaptivity.*

H 2.2 9. *Users of personalised cancer websites find adaptability more useful than adaptivity.*

Research on location-aware marketing explored the association between individual's characteristics and personalisation approaches, and indicated that users who are open to obtaining personalised services are more inclined to adaptivity [83]. Stemming from the *first research proposition*, the research in this thesis tried to *establish whether there is a link between user background, or their affective state, and their preference for or perception of usefulness of the website's personalisation approach*. It was hypothesised that:

H 2.2 10. *Depending on their background, users differ in their preference for a personalisation approach.*

H 2.2 11a. *Users experiencing negative emotions of high intensity perceive adaptivity useful (they prefer adaptivity).*

H 2.2 11b. *Users experiencing positive emotions of high intensity perceive adaptability useful (they prefer adaptability).*

3.3.5 Satisfaction with website personalisation

The third personalisation-related factor is *satisfaction with website personalisation*. It measures how satisfied a user is with the personalised services on the PORT cancer website. Satisfaction is a widely adopted measure for evaluating HCI. Therefore, in

understanding whether users of cancer websites are satisfied when personalisation is introduced to the website, it was hypothesised that:

H 2.3 12. *Majority of users express satisfaction with cancer website personalisation.*

Previous research findings: User satisfaction was found to be positively affected by personalisation [193], particularly information personalised to user preferences [236]. Also, research applied to health websites showed there is a greater possibility that users who perceive the website as knowledgeable, responsive, and with good design, will be satisfied with it [101]. Different features were found to influence user satisfaction with news websites; for example: navigation, accurate and new information, presentation of information, availability of new multimedia, website design – particularly background, colours and layout [237]. The majority of these features can be provided with personalisation, especially those related to navigation, presentation of relevant information, and website layout and appearance adaptation. Hence, this research *explored the correlation between the usefulness of personalisation features and satisfaction with the personalisation*, when applied to a cancer website, as hypothesised:

H 2.3 13. *If users perceive cancer website personalisation features as useful, they will also be satisfied with the website's personalisation.*

3.3.6 Website usability

This research measured the *usability of a personalised cancer website*. Well established and widely applied usability instruments were adopted; Computer Usability Questionnaire (CSUQ) [238] and User Interface Satisfaction (QUIS) [239] in two studies, and System Usability Scale (SUS) [220] in the last two studies. Usability measures the ease and appropriateness of use of the available system's functions [11].

Usability is another commonly used measure [11, 82] for technology acceptance. It was applied to personalised online recommender systems [240], as well as e-health websites [11]. This research combined the two domains and *evaluated the usability of a personalised cancer website*, further explained in Section 3.4 of this chapter. It was

further hypothesised here that user background, especially the effect of cancer on a user's life, will reflect on their perception of website's usability, such that:

H 2.4 14. *Background characteristics influence how usable users perceived a personalised cancer website.*

Previous research findings: Previous research showed that system functionality has a positive influence on usability [241], software design focusing on functionality negatively affects usability [242], and importantly for this research, it was suggested that customisation introduces complexity in system functionality, and therefore, has a negative effect on usability [243]. For e-health websites, the majority of users considered website functionality to be more important than usability [11]. Thus, this research considered the effect of user perception of personalisation features (a functionality factor) on the website usability, in the following hypothesis:

H 2.4 15. *The more useful cancer website personalisation features are perceived, the higher the website usability.*

3.3.7 Post-use emotions

The emotions-related constructs were introduced in Section 3.3.2. This section specifically presents the research model relations for the *post-use emotions* factors. Stemming from the *second research proposition* of this thesis are the hypotheses that test the impact of users' perception of the website's personalisation services – including user satisfaction, perceived usefulness and usability - on post-use emotions, as follows:

H 2.5 16a. *Negative emotions post-use have **lower intensity** than negative emotions pre-use.*

H 2.5 16b. *Positive emotions post-use have **higher intensity** than positive emotions pre-use.*

H 2.5 17a. *The greater the **satisfaction with website personalisation**, the less intensely are negative emotions experienced after website use.*

H 2.5 17b. *The greater the **satisfaction with website personalisation**, the more intensely are positive emotions experienced after website use.*

H 2.5 18a. *Users who do not perceive the website as **usable** will experience high intensity of negative emotions post website use.*

H 2.5 18b. *Users who perceive the website as **usable** will experience positive emotions in high intensity post website use.*

H 2.5 19a. *Perceived **usefulness of adaptivity or adaptability** increases the intensity of post-use positive emotions.*

H 2.5 19b. *Perceived **usefulness of adaptivity or adaptability** decreases the intensity of post-use negative emotions.*

3.3.8 Website reuse intentions

The dependent factor of my proposed research model measures ***intentions to reuse a personalised cancer website***. This section introduces the *reuse intentions* factor and the related relations that were hypothesised for it in this research.

Previous research findings: It was found that perceived personalisation has a significant positive impact on intention to adopt recommendation agents [126]. Furthermore, customers who perceive that online personalisation is of greater quality have higher intention to use a personalised online financial services [221]. Given the *positive effect of introducing personalisation on intentions to reuse online services* in other domains, it was hypothesised here that:

H 2.6 20. *People affected by cancer intend to reuse a personalised cancer website.*

The most important factor influencing intentions to revisit an online shopping website was shown to be satisfaction with product information and claims [244]. Positive experience with a system, evoking satisfaction, increases the likelihood of future use of the system [124]. In non-compulsory website usage, satisfaction seems to be the key factor positively influencing willingness for a return visit [245]. While other studies showed otherwise [246], Topaloglu et al. [11] found that satisfaction was the least important usability sub-factor for e-health website reuse. Furthermore, it was indicated that usability did not influence satisfaction on e-health websites, but might be important in forming the first impression [247]. Given the discrepancy in the previous studies, the research in this thesis explored whether the introduction of personalised features on a cancer website affected users' *satisfaction* with the service offered and their perception about the website *usability*, and consequently *influenced their intentions to reuse the website*. Hence, it was hypothesised that:

H 2.6 21. *Satisfaction with cancer website personalisation and intentions to reuse the website are positively associated.*

H 2.6 22. *Usability of a personalised cancer website and intentions to reuse the website are positively associated.*

Moreover, in the *third research proposition* I argue that cancer website reuse intentions are also determined by emotions resulting from the interaction with the website. Previous research showed that personality was related to online health information disclosure intentions [124]. A study in e-shopping showed that personalisation and positive emotions increase purchase intentions [53]. Thus, this research hypothesised that post-use emotions are associated with users' subsequent intention to use a cancer website:

H 2.6 23a. *The higher the intensity of post-use positive emotions, the higher the website reuse intentions.*

H 2.6 23b. *The lower the intensity of post-use negative emotions, the higher the website reuse intentions.*

3.4 User preferences for emotion-based personalisation on cancer websites (RQ 1)

This section addresses the hypotheses of the first research questions (RQ 1), which are not part of the research model relations. They answer the questions whether personalisation, and moreover emotion-based personalisation, is preferred for a cancer website, over non-personalised services, as follows:

RQ 1.3. Do cancer website users prefer personalisation? Do users perceive a personalised cancer website more usable?

RQ 1.4. Do cancer website users prefer emotion-based personalisation?

The *website usability* factor was used to compare the different versions of the PORT cancer in terms of user preference for the level of personalisation each version offered. An additional measure - *preference for website version* – was introduced in Study 5. It required participants to specifically express which PORT website version they preferred in terms of the personalisation services it offered. The 4-alternative forced choice (4-AFC) questionnaire protocol [179, 248] was used for these purposes.

Previous research indicated that extending website functionality can negatively reflect on its usability [249]. Therefore, this research explored whether *introducing a greater variety and more advanced personalisation features affects the usability of a cancer website*. Hence, the hypotheses that follow are:

H 1.3 4. *A personalised cancer website is perceived more usable than a non-personalised one.*

H 1.4 5. *Users find the cancer website with emotion-based personalisation more usable than the one with generic personalisation, and the latter more usable than the non-personalised website.*

H 1.4 6. *Users of cancer websites prefer emotion-based personalisation to generic personalisation services.*

3.5 Summary

This chapter presented the conceptual framework for exploring reuse intentions for personalised cancer websites. It presented the research questions that guided this research. It introduced the three research propositions grounded in the existing theory, but also extending it. It then defined the research constructs and linked them to the propositions and hypotheses they refer to.

The next two chapters address the methodology of this research. Chapter 4 discusses the research design in terms of the methods used for sampling and data collection, approaches applied for experiment design, and specifically explained for each of the five studies performed in this research. Chapter 5, on the other hand, focuses on the techniques applied in design and development of the PORT cancer website, furthermore also illustrating characteristic website features and demonstrating the functionalities related to emotion-based personalisation and adaptation.

Chapter 4

Methodology and research design

Chapter 4 discusses the different methods that were adopted to carry out this research. It specifically addresses the methodology used in collecting and pre-processing the primary data, which was the basis of the five empirical research studies performed here. Therefore, this chapter reviews the sampling techniques used and the different sampled populations (RObj1). It presents the data collection methods used here, including: questionnaires, interviews and website logs. Finally, the chapter describes in detail the design of controlled experiments (RObj6), which were performed in four studies of this research.

4.1 Overview of research methodology

In essence, the research carried out here was predominantly *primary research*. *Secondary research* was employed in the literature review stage (RObj1), as was summarised in Chapter 2. Moreover, *deductive, hypothesis-driven, research* [250] was applied in reviewing the existing models and theories to infer the research constructs of the conceptual framework presented in Chapter 3. This is in comparison to the data-driven, inductive, research [251] which was employed only to a limited extent in this thesis. The implementation of the two approaches is discussed in detail in Section 4.6.

Given the unavailability of data related to emotions and personalisation when applied to cancer websites, primary research had to be carried out. Thereby, different methods were used to collect primary data to answer the two main research questions: RQ 1 – whether users prefer emotion-based personalisation for cancer websites, and RQ 2 – whether emotions affect the perception of personalisation and in turn also reuse intentions. This was achieved via a number of different types of studies, including *exploratory*, *descriptive*, *explanatory* [252], as well as *confirmatory* [253]. In the research methods literature, another type of studies is mentioned - *interpretative* studies [252]. Interviews

carried out in Study 1 of this thesis could be classified as *interpretative* studies, as they were qualitative in nature [252], with the aim to explore the experience of cancer-affected people with the healthcare system in B&H and the emotional effect of being diagnosed with cancer. Nevertheless, the former four study types prevailed in this research.

Exploratory research in this thesis studied the relations between various previously unexplored or underexplored factors. These were for example: the correlations between user emotions and perceived usefulness of personalisation; the influence of these two factors on website reuse intentions; exploring the context of personalised cancer websites; measuring these effects for the cancer-affected population; and exploring the effects in understudied environments as is B&H. All the studies performed in this thesis included a *descriptive* research component (e.g., presenting the measures of central tendency for the demographic user data, or for latent variables). Furthermore, the *explanatory* approach was adopted to understand, infer and explain implications from the relations between the research framework's constructs. In order to confirm inconsistent findings, follow-up studies and triangulation was used throughout this research. Therefore, the *confirmatory* research approach was applied as well.

Studies can also be differentiated, based on their design, into the following general groups: *meta-analysis*, *state-of-the-art review*, *descriptive* (e.g., case reports, surveys and qualitative studies), *experimental* (primarily controlled experiments) and *observational* (e.g., cross-sectional and case-control studies) [254, 255]. In this thesis, meta-analysis was not used. While it can give useful insight into the distribution of different methods and types of findings obtained in previous research, generally, there is a very limited amount of studies on emotion-based personalisation, and these were reviewed as related work (Chapter 2) for this thesis. Moreover, this research's main aim was conducting studies that collect primary data. The other study designs were employed in some form.

A systematic review of the emotions- and personalisation-related research was carried out within Chapter 2 and 3, as well as a state-of-the-art review of personalisation in online health services (Study 1). Study 1 was mainly a descriptive study of cancer-affected people's views on using personalisation for online health services. Additionally, two

descriptive interview-based studies were carried out within Study 4 and Study 5. Experimental study design was employed from Study 2 to Study 5, as these required interacting with and evaluating the PORT website on a number of measures, as well as comparing the results for different target user groups. Finally, observational research was carried out in Study 4 and Study 5, where participants were shown the PORT website and asked to freely interact with it, while the user interactions were being recorded within website logs, or I, as the researcher, was taking notes on the observed user behaviour.

Five empirical studies were performed throughout this research. They tested the hypotheses proposed in the research model, through *mixed-methods approach* [256], including - surveys, interviews, website log data and website use experiments. *Quantitative* and *qualitative* data was collected. Nevertheless, *quantitative techniques* predominated as more applicable for statistical inference of research model relations, and for other statistical analyses this research undertook [257].

With respect to time within which the data is collected, we can classify research into cross-sectional, longitudinal, and their combination, sequential design [258]. Cross-sectional research prevails in academic undertakings, due to the common time constrain [259]. I thus opted for **cross-sectional** design in the five studies of this research, which measured the researched factors for the different categories of the cancer-affected people in a snapshot in time. Additionally, one **longitudinal study** (Section 4.3.3.1) was conducted to complement the results.

The **five studies** carried out within this research were reviewed and approved by the University of Warwick Biomedical and Scientific Research Ethics Committee (BSREC), under the BSREC reference numbers: REGO-2014-608, REGO-2014-1270, REGO-2015-1421, REGO-2016-1750, REGO-2016-1823. A brief overview of the studies is outlined next, while their *results are reported in Chapter 6 and 7*.

- **First study:** was run between *April* and *May 2014*. It reviewed the state of the art of online health services, specifically investigating the availability of personalisation on existing health websites in B&H and the UK. It identified the various categories of people affected by cancer, and explored their requirements

for personalisation features on cancer-related health websites. Additionally, it looked into whether emotions stimulate the use of online health services. The sample of target users was drawn only from the B&H population.

- **Second study:** carried out *October – November 2014*, evaluated the personalisation introduced to the PORT cancer website in its first version (Phase I version). Additionally, it explored the effect of emotions on user perception of the personalisation services. The sample of target users was also drawn only from the B&H population.
- **Third study:** performed *March - June 2015*, sampled target users from a wider, global population. An emotion measuring instrument was introduced to the PORT cancer website (Phase II version). The study sought to establish whether emotions have an impact on user preference for personalisation features.
- **Fourth study:** carried out *March - April 2016*, evaluated the PORT website after emotion-based personalisation and adaptation were implemented (Phase III version). Global population of target users was sampled. Target user preferences for emotion-based personalisation, generic personalisation and no personalisation on a cancer website were explored. This was also a confirmatory study, retesting the conceptual framework relations.
- **Fifth study:** was carried out from *October to November 2016*. This was a confirmatory study, which re-evaluated user preferences for personalisation services, after refining the emotion-based personalisation on PORT cancer website (Phase IV version).

4.2 Sampling

Sampling methods can be classified into two main groups, which are probability and non-probability sampling [260, 261]. **Non-probability** sampling methods, specifically *convenience*, *purposive* and *respondent-driven* sampling, were applied to this research. Non-probability sampling is commonly used in HCI studies [260]. This approach is taken when employing probability methods is difficult, due to inaccessibility, unwillingness or inability of the target population to participate [261] - barriers which existed in my

research. Hence, by employing *convenience sampling*, easily accessible populations were sampled; for example: students, social networks' users, and participants on crowdsourcing services. Moreover, *purposive sampling* specifically aimed at representatives of the cancer-affected population, e.g., cancer associations' members - cancer sufferers, caretakers, and supporters. Such non-probability sampling methods have been used in prior studies related to online health [261-263].

The next sections discuss the different populations that were sampled. The sections review the participant numbers and sample sizes of the five studies.

4.2.1 Sampled groups

To ensure broader applicability of this research, various populations were sampled including:

- members of different B&H cancer associations, particularly:
 - registered users on the PORT Association's website
 - followers of the PORT Association's Facebook page
 - followers of UNA Association's Facebook page
 - members of the associations - Srce, Biser, Renesansa and Nada Jajce;
- participants in crowdsourcing services - Amazon Mechanical Turk and Clickworker.com;
- users of social networks, specifically:
 - my Facebook contacts
 - users of the forum of the Philosophy department at the University of Sarajevo, B&H
 - users of a cancer forum on the *klix.ba* [264] online portal;
- university students – University SSST, University of Warwick, University of Jordan.

Members of B&H cancer associations were sampled from the main target population. The members comprise cancer patients, caretakers (including family and friends) and

those supporting cancer association initiatives. Given that cancer associations in B&H were mainly founded by a (former) cancer patient, and were organised around people who were either suffering or had suffered from cancer, people who were directly affected by cancer were also included in the sample of participants.

From some 20 active cancer associations in B&H in the period 2014-2017, 12 associations had accessible contact information and were invited to: distribute the paper questionnaire (Study 1), advertise the online questionnaire on their website or Facebook page (Study 1 - 4) or participate in the interviews (Study 3 and 4). The B&H cancer associations that participated in this research are:

- PORT Association for people affected by malignant diseases (distributed online surveys to its followers; 310 Facebook followers in 2017)
- Biser Association for breast cancer sufferers (25 members; all members participated in Study 1 survey)
- Sree Association for children with cancer (400 members; distributed paper questionnaires and interview invitations to its members; Study 1: 10 members participated, Study 4: 5 members participated)
- ‘Nada’ Jajce, association for people suffering from cancer (350 members; distributed interview invitations; Study 4: 8 members participated)
- Renesansa Association for breast cancer sufferers (their founder was interviewed in Study 4)
- UNA Association for breast cancer sufferers (around 500 Facebook followers (659 followers in 2017); promoted Study 1 online survey to its followers).

Crowdsourcing services were also used, from Study 3 onwards. Experiments using crowdsourcing services have been used in previous emotion-related studies, e.g. [265]. In this research, *Amazon Mechanical Turk (AMT)* [266] and *Clickworker.com* [267] were used. Participants who were recruited via the crowdsourcing services represented the more global population of people affected by cancer. AMT workers are generally based in the US, while Clickworker.com recruits workers from most of the European Union countries, the US, Canada, India, Russia, South American countries and South Africa.

Users of social networks were sampled in all the five studies. These were primarily users of the Facebook social network, and university-based and cancer forums in B&H. Other emotion-related studies also used social networks to advertise their experiments and research [268]. The use of such online channels enabled reaching primarily younger to middle aged populations (students, and researcher's contacts and cancer forum users generally belonging to the 25-35 age group), hence people who are more likely indirectly affected by, or interested in cancer, who use the Internet, also for health and cancer information search.

University students represent the population of people who might not be directly affected by cancer, but affected via a family member or a friend, or interested in informing themselves about cancer for prevention/detection purposes. Students are considered typical Internet users [269] and have commonly participated in studies on online system use or adoption [124, 269], including the use of health websites [11]. For example, Topaloglu et al. [11] sampled students in Turkey to evaluate the usability and functionality of e-health websites. They claimed their choice of sample was justified, as the most likely and frequent users of Internet in Turkey were in the age group 16-24, and mainly students or graduates [11]. As representatives of the younger population, students can also be considered more tech-savvy and interested in exploring new technologies. Hence, *students can represent the potential users of a personalised cancer website*.

Several **universities** participated in this research, specifically the University Sarajevo School of Science and Technology in B&H (University SSST), the University of Warwick in the UK, and the University of Jordan. The course lecturer or I (the researcher) sent out an invitation e-mail to the sampled students, informing them of their withdrawal rights, the procedure, venue and time, and the link to the online survey. Students were supervised during the experiments either by the researcher (at the University of Warwick and University SSST), or the course lecturer (the researcher's former colleague recruited and oversaw students at the University of Jordan).

The limitations of using student samples are addressed in Chapter 9 (Section 9.2.3). To alleviate these limitations, other populations were also sampled in this research.

4.2.2 *Sample size*

In calculating a study's **sample size**, *all categories of people affected by cancer* (cancer patients, indirectly affected, and those interested cancer information) were taken into account. Raosoft sample size calculator [270] was used, setting the confidence level at 95%, response distribution at 50%, and margin of error from 5 - 8%. These parameters were set in determining the sample size from the populations the individual studies were advertised to, as next explained.

Study 1 sample of cancer-affected people was drawn *entirely from the B&H population*. The justification for this choice was provided in Chapter 1, as it was deemed necessary to deduce the requirements for cancer website personalisation from users in a context which was not tampered by previous attempts at personalisation. According to the 2012 statistics, in the population of approximately 3.7 million people, there were 9,911 new cancer cases in B&H [271]. The approximate size of the indirectly affected population was 96,466, i.e., 9,911 cancer patients, with at least 3 family members and 2 close friends, and a conservative estimate that 1% of the overall B&H population is interested in cancer. The estimate was based on the data provided by Association Hope (U.G. Nada) from a B&H town Jajce, which has a population of 22,000. Association Hope has 350 members, of which 130 cancer sufferers, while the remaining members (approximately 1% of Jajce's population) have reportedly joined the association to raise cancer awareness. Thus, for the B&H population of cancer-affected people, the recommended sample size was 150 people.

The populations to which the study was advertised, and were hence sampled, included: 260 followers on Facebook page of the PORT Association; 500 followers on Facebook page of the UNA Association; 270 contacts on my (the researcher's) Facebook page; 25 members of the Biser Association; and 10 members of the Srce Association.

In **Study 2**, the sample was also acquired only from the *B&H population of people affected by or interested in cancer information*. The populations to which this study was advertised included: 95 members on PORT's original website, 280 followers on PORT's Facebook page, 270 contacts on the researcher's Facebook page, and 22,000 members on

the various university forums in B&H. Additionally, 50 undergraduate students attending the University SSST were recruited for this study. Hence, the calculated sample size, based on these populations, was of 378.

Study 3 was the first study in which the *pool of participants was expanded to outside B&H*, to generalise the results to a larger cancer-affected population. The study was advertised to the following populations: 280 followers of PORT's Facebook page, 270 contacts on the researcher's Facebook page, 32 participants via AMT crowdsourcing, and 95 undergraduate students at the University SSST. Based on the parameters identified in the first paragraph of this section and when summing up the here identified populations, the recommended sample size for this study was of 246 people.

Study 4 sampled the *cancer-affected population from a number of countries worldwide*, including B&H, US, UK and Jordan. Chapter 7 (Section 7.2.3) presents a detailed distribution of participants by countries. The sample size of 385 was approximated from the proportion of worldwide cancer affected population (33 million [2]) who use online health services. The populations this study was advertised to, were as follows:

- AMT crowdsourcing workers – 18 participants (all participated; the limited budget and lengthy survey/experiment allowed recruiting only a small number of crowdsourced participants)
- undergraduate students at the University SSST - 33 students (all participated)
- undergraduate students at the University of Jordan - 61 students (all participated)
- PhD students, researchers and lecturers at the University of Warwick – 20 participants (all participated)
- the researcher's Facebook friends and followers – 300 contacts (a minor number participated)
- PORT's Facebook page followers - 306 followers (a minor number participated)

Study 5, which was a *follow-up study*, was entirely based on convenience sampling, i.e., recruiting a small number of target participants, accessible to the researcher via crowdsourcing services and personal contacts, to test and clarify the results of the previous four studies. The aim was to recruit 20 to 40 participants for each of the three experiments performed during this study. Two recruiting channels were used:

crowdsourcing services - AMT and Clickworker.com (for the Improvement experiment: 40 participants; the Usefulness experiment: 12; and the Interaction experiment: 40), and the researcher's contacts on social networks (for the Usefulness experiment: 15 participants).

4.3 Data collection methods

As stated at the beginning of the chapter, both qualitative and quantitative data was collected in this research; the different types of gathered data are further explained in the next sections. Depending on data collection method and type of data collected (e.g., primary vs. secondary, qualitative vs. quantitative), the following approaches are commonly identified in the literature [256, 272, 273]: interviews, focus groups, case studies, questionnaires, tests, observations, secondary data (e.g., documents, physical and archived data), automated logging - web/system logs on usage data, as well as a combination of these.

Mixed-methods approach [256] was used throughout this research, where two or more methods were combined for data gathering. In the literature reviewed for this research, the majority of studies used the survey questionnaire method, e.g. [11, 54, 124, 149, 151, 191]. Others employed interviews [151], sentiment analysis [274], state-of-the-art review [93], and logging system usage data [54, 149], all methods which were applied to this research as well. The different data collection methods that were used here include:

- Questionnaires (as part of surveys and experiments) – self-reporting by the target population (Study 1, 2, 3, 4, 5);
- Interviews and focus group with people affected by cancer (Study 1, 4, 5) and a B&H health website provider – PORT Association (Study 1);
 - Observations of user interactions with the PORT website (Study 5)
- Website log files; tracking and recording user activities on the website (Study 3, 4, 5);
- Longitudinal data on target user interactions with PORT website (Study 4).

Heuristics - Evaluations of B&H and UK health websites (Study 1); **4.3.1 Survey questionnaire**

Most often cross-sectional studies opt for survey questionnaires, as the most convenient method when faced with time limitations [90]. My research mainly used online questionnaires, given the convenience, lower cost, faster distribution and lower error rate in response recording, compared to the paper-based questionnaires. Google forms were used as a free, convenient tool for developing surveys, with sufficient storage capacity and security. In addition to the online questionnaires, paper-based questionnaires were used only in Study 1 (entirely survey-based).

The surveys (containing questionnaires (Study 1-Study 5) and descriptions of experiment procedures (Study 2-Study 5)) were developed in English. Given that a significant portion of the sampled population in this research was from B&H, the surveys were also translated into Bosnian. In Study 4, the survey was additionally translated into Arabic, with the help of the course instructor at the University of Jordan. Therefore, surveys in this research were distributed in English and Bosnian to Bosnian participants, in English and Arabic to Jordanian participants, while participants from other countries were provided with the questionnaire version in English.

At the beginning of each survey questionnaire, participants were informed about the objective of a study, the experimental procedure and their ethical rights. In the first four studies, surveys were organised to first present the experiment instructions, and only after all experiment tasks were completed, a questionnaire was shown. However, survey organisation was changed in Study 5, to ensure that users notice the website features they were asked to evaluate. Study 5 participants were, hence, instructed to interact with only a few features on a single segment of the PORT website, and immediately afterwards asked to evaluate the features they had interacted with.

The next two sections discuss the type of questions used in the surveys, and addressing in greater detail the instrument used for measuring emotions. Appendix B gives a detailed inventory of the questionnaire items used in the five studies.

4.3.1.1 Type of questions

Questionnaire items were, for the majority part, adopted or adapted from prior related research (see Chapter 3, Table 3.3), however some measures were self-developed. Two general types of questions are used in questionnaires – closed-ended and open-ended [275]; whereby the former require a selection of one or several of given response options, while the latter enable participants to express their views in their own words. The questionnaires in this research mainly comprised *closed-ended* questions, which included: dichotomous, multiple choice, multiple response, and grid or rating scale. The questionnaires were divided into *several sections*, each *addressing a single research construct*. Questionnaire instruments used in this research are shown in Appendix B.

The *first section* generally collected ***user background*** data (apart from Study 1 where it was collected at the end). This included a mixture of demographic questions (where users were provided a textbox to type in their response), e.g., age, and multiple-choice questions, e.g., how cancer affected the respondent.

It was normally the *second* and the *last section* that presented the ***emotion measuring instrument*** for self-reporting emotions experienced before using the PORT website and after interacting with the website, respectively. Section 4.3.1.2 of this chapter explains the instrument in detail.

The *third section* presented the instrument for evaluating ***personalisation features***, in terms of *usefulness*. This was a grid-type question, which listed the personalisation features in rows and the rating scale in columns. Usefulness was rated on a 5-point scale (1 to 5) for *level of agreement* in Study 3 and 4, and on a 5-point scale (-2 to 2) for *level of usefulness* in Study 2 and 5. The aim was to reduce the effect of the scale used on participant responses, as well as to simplify and clarify response options, particularly in the follow-up study (Study 5). In Study 1, availability and preference for a feature was expressed by selecting from multiple choices.

The features that were evaluated in Study 1 were the adaptive and personalisation features commonly identified in the adaptive hypermedia literature [75, 79, 80] and

studies on online personalisation [77]. In Study 2 to Study 5 the personalisation features that were evaluated were the ones that were implemented on the PORT website. Therefore in these studies, participants were inquired on their perception of the personalisation features they experienced on the PORT website. The lengthy list of personalisation features (in all studies more than 20 features, i.e., questionnaire items), was randomised in the last two studies (Study 4 and 5), to account for the factors of fatigue and participants' inclination for straight-lining. The complete list of personalisation features evaluated in the five studies is provided in Appendix C.

Commonly, the *third section* also included an instrument for measuring a preference for an ***approach to personalisation***. In Study 1 users were asked which *approach to providing personalisation features* (system controlled or user controlled) they preferred for each feature evaluated. In Study 3, participants expressed their perceived *preference* towards *adaptivity* or *adaptability*, via five questionnaire items stating either an adaptive or adaptable personalisation service.

Note that, in measuring the factor *preference for adaptivity vs. adaptability*, **reverse coding** was applied. As can be seen in Appendix B, three of the items of this factor expressed a preference for adaptability, and two a positive attitude toward adaptivity. The factor itself was measured as an overall attitude toward adaptability. Thereby, to ensure that all the five items express a positive attitude towards adaptability, the two adaptivity oriented items were reverse coded. For example, the item: *I prefer the system to tailor its features automatically*, with a response *Yes*, was re-coded into: *I do not prefer the system to tailor its features automatically*, with a response *No*.

Finally, in the last two studies, *usefulness of adaptivity* and *usefulness of adaptability* were measured. The latter two constructs were measured by classifying the list of items used for the factor *usefulness of personalisation features* into website services that perform automatic tailoring (adaptivity) and, on the other hand, those that require user customisation (adaptability). Chapter 7 (Section 7.1.2) provides a detailed list of the items of the two factors. Furthermore, the same 5-point rating scale for the level of agreement was used.

The *fourth section* presented the instrument for measuring ***satisfaction with website personalisation***. This construct's items were adapted from the following factors that were explored in previous studies: *personalisation quality* [221], *perceived personalisation* [126], *satisfaction* and *usefulness* [222], *site quality* [223], *personalisation* [83], and *motivation* [219]. Nevertheless, the instrument used here was adjusted to reflect the type of personalisation offered on the PORT website. Hence, users evaluated *website appearance*, *ease to find* and *relevance of content*, matching the content to user interests and emotions, etc. (see Appendix B for detailed items and scales). A 5-point Likert scale for the level of agreement was used in this case.

The instrument for measuring ***website reuse intentions*** was presented in a separate questionnaire section. The items for this construct were adopted from several studies that measured: *intention to purchase* [83, 125], *behavioural intentions* [90], *likelihood of usage* [221], and *the intention to adopt* [126]. In Study 2 and 3, the reuse intentions instrument comprised five items, these were reduced to three in Study 4. The two excluded items ('I intend to revisit', and 'I intend to use frequently') were comprised in the remaining items ('I intend to use again'). The reduction of items did not significantly affect the factor's reliability, which was sufficiently high with three items, however it simplified and shortened the survey and reduced the demand on participants. A 5-point Likert scale for the level of agreement was used here as well.

Website usability instrument was included in the questionnaires for Study 2 to Study 5. In all the studies, a 5-point Likert scale was used to rate the level of agreement with the items measured. The instruments used in Study 2 and 3 were based on a subset of questions selected from the Computer Usability Questionnaire (CSUQ) [238] and User Interface Satisfaction (QUIS) [239] (see Appendix B). These questionnaires contain a larger set of questions (19 and 27 respectively), however, it is not an uncommon practice for a subset of questions to be selected [82]. The last two studies used the System Usability Scale (SUS) [220] instrument. SUS has fewer items (10 in total), enables calculating a score and easily comparing usability across different website versions or other similar systems. Moreover, using different usability instruments enabled comparing the consistency of the findings across the studies (Chapter 6).

The previously mentioned **reverse coding**/scoring was also applied to the *usability* items (see Appendix B). In calculating the usability score using the SUS instrument, reverse coding is incorporated in the calculation. However, in Study 2 and Study 3, I had to reverse code the negatively worded items. For example, the item: *I did not feel confident using the PORT website*, was reworded into: *I felt confident using the website*. Thereby, the scale was reverse scored, so that the previous *strongly agree* response, was a *strongly disagree* response on the re-coded item, and vice versa. Thus, the values of the scale 1-5, all referred to the same type of response for all usability items, and all items were worded in the same direction.

At the end of a survey, an *open-ended question* was presented. Participants were invited to provide feedback, comments, remarks, complaints or suggestions they have with regard to their experience in using the PORT website, or any general suggestions.

The longer surveys, as the one in Study 3, additionally included **trap questions** in different sections of the questionnaire. These were for example – *What is the first letter of the alphabet?* – which required obvious answers. They served for validation purposes, to assist in filtering out random responses.

4.3.1.2 Instrument for measuring emotions

As explained in Chapter 2, this research adopted a *self-reporting method for measuring emotions*. The emotion measuring instrument was presented in a questionnaire, before and after website use. In addition, the *Emotion Tool* - a tool for measuring emotions - was present on the website. The Emotion Tool contained the same emotion measuring instrument as presented in questionnaires; it had the same inventory of emotions and used the same intensity scale. Its unique aspect is that it was incorporated into the website as one of the website features, and it collected, stored and used the reported emotion data automatically.

Chapter 2 (Section 2.4.3) introduced the various methods for measuring emotions, including the validated self-reporting instruments, such as SAM, DES, PAD and OCC

model. Other self-reporting tools, such as mood tracking apps (Chapter 2, Section 2.4.3), the PANAS questionnaire [276] and Affective Slider [277], could also be considered (a limitation addressed in Section 9.2.9). However, the *instrument used in this research was self-developed* for the reasons explained in Chapter 2 (Section 2.4.3), among which was the need not to be restricted by copyrights in adapting the instrument and the need to have it available for use on the PORT website.

The *inventory of emotions*, as explained in Chapter 3 (Section 3.3.2), was drawn from a number of emotion taxonomies that identified the *common basic emotions*. Furthermore, the emotion measuring instrument used here adopted elements from the DES [154] and SAM [140] instruments; whereby, participants report the varying intensities [127] of the explored discrete emotions or affective states. A *5-point intensity scale* was used; an emotion was experienced with an intensity of: *0: not at all, 1: mildly, 2: moderately, 3: very, and 4: extremely*. The scale was adopted from a game experience questionnaire [278] and other studies connecting emotions and online systems [141, 151]. The set of emotions measured in the five studies and the changes made to the rating scale were shown in Chapter 3 (Table 3.4). The range of the scale was adjusted to 0-4 in Study 5, as it was considered that 0 better corresponds to the state of no intensity, i.e., an emotion not being experienced at all.

In addition to the questionnaire-based instrument, the *Emotion Tool* was used to *collect data on self-reported intensities of emotions during the use of PORT website*. Collecting emotion data via post-experiment self-reports can be questionable, given that it is often difficult for people to reflect on their affective state [54]. As suggested in research that used a similar measuring method [54], in order to improve user involvement and response frequency, the Emotion Tool was *present permanently in the form of a dialogue box* on the PORT website (from Phase II of development). The dialog box *appeared automatically* after a user logged in, and after every content rating. Additionally, *users could click on the Emotion Tool icon* to report their emotions at every point of website use. Moreover, to stimulate self-reporting [54], users were instructed in the research experiments at which website interaction activity to use the Emotion Tool.

4.3.2 Interviews and focus group

Structured interviews were conducted in Study 1, Study 4 and Study 5. The interviews were carried out in B&H, with *representatives of the cancer-affected population*. All interviewees were informed about the research, their right to withdraw, and asked to sign the consent to participate. The purposive method was used in sampling. *Interview invitations* were sent out to the following:

- President and founder of a cancer association for breast cancer sufferers;
- Members of a cancer association that is active in a smaller B&H city;
- A medical doctor who was a cancer patient;
- Two acquaintances of the researcher; a former and a current cancer patient;
- Cancer association for children fighting cancer;
- Two university students who recovered from cancer they had as children.

The invitation was also posted on:

- PORT Association's Facebook page;
- MladiCe BiH – a Facebook group of young adults who battled cancer as children or are still battling it;
- and twice on the klix.ba [264] cancer forum (December 2015 and February/March 2016).

There were *several interview rounds*: the first with the founder of the PORT Association; three more with different representatives of people affected by cancer as potential users of the PORT website. Throughout this research, 25 people were interviewed.

The *founder of the PORT Association* was interviewed in April 2014 in Sarajevo, B&H, for approximately one hour. The aim of the interview was to obtain information about the website PORT Association used at that time, the availability of personalisation on health websites in B&H, or the reasons for the lack of it.

In the *first round of interviews with the representatives of the cancer-affected population*, fifteen people were interviewed in two B&H cities in March 2016. *Eight participants*

(women, cancer associations' members) were interviewed about the *state of healthcare* for this population in B&H and their use of health websites for cancer information. *Seven participants* were interviewed with the aim to clarify the *effect of emotions* when informing oneself about cancer.

The *second round of interviews with cancer-affected people* aimed at gaining a better understanding into *target user preferences between no personalisation, generic personalisation and emotion-based personalisation on a cancer website*. *Four people* affected by cancer from B&H were interviewed in March and April 2016. The interviews were organised in public places, and one was conducted via Skype. The interviewees participated in the experiment where they interacted with three versions of the PORT website with different levels of personalisation, which were shown in a random order to each interviewee. The researcher provided a laptop with an Internet connection to access the PORT website. On average, the interviews lasted between 1 and 1.5 hours. A more detailed overview of the Study 4 interview, including its methodology, questions and responses is provided in Appendix I, while the interview findings are presented in Chapter 6 (Section 6.5.4.1).

The **final round of interviews** (part of Study 5) was carried out in March 2017, in Sarajevo, B&H. The aim was to *interview people who were or are currently battling cancer, and specifically repeat visitors*, i.e., **long-term users**, who have become familiar with the PORT website and its functionalities, by using it over a certain period of time. The interviews followed up on the final research results related to: the *type and level of personalisation preferred* by users for a cancer website; the type of *personalisation features users like* and dislike on the PORT website, particularly focusing on the emotion-based personalisation features.

The **interviewees** were two cancer patients – young male, cured from osteosarcoma; and a female in early thirties, currently being treated for lymphoma. *Both interviewees have previously learned about the PORT website and have used it over a certain period of time*; thereby these interviewees can be considered *representatives of long-term website users*.

Furthermore, within the final round of interviews, a *focus group* with adolescent cancer survivors was formed, to discuss the level of personalisation they preferred on the PORT cancer website. Three females and two males, aged 16 – 18, who are members of the MladiCe B&H – a network of young cancer survivors from B&H, participated in the focus group meeting.

The duration of the interviews was between 1.5 and 2 hours. The focus group meeting took approximately 1 hour. Unlike the previous interviews where participants explored the website themselves, in these interviews I *demonstrated all three PORT website versions* - without personalisation, with generic personalisation, and with emotion-based personalisation – *and pointed out the differences*. The websites were shown in a consecutive manner, starting from the version without personalisation and ending with the emotion-based personalisation. For each website version, the features and content which were in common with the other two website versions were pointed out, as well as the unique functionalities. For generic personalisation, I showed how providing different user information, defining interests and expressing preferences through content rating, affected the changes in content recommendations. Comparatively, I demonstrated that, in addition to the previously listed user information, the website with emotion-based personalisation also required collecting emotions at different stages of website use. Furthermore, I pointed out that the changes in emotions reflected on both content recommendations, as well as the adaptation of website features and content.

The interview questions, that followed after the website showcasing, first expressed what this research has so far found on a particular topic, then asked the interviewees about their opinion why such a finding was obtained, as well as what their preference or choice would be. Appendix J provides a more detailed overview of the interview procedure and the list of questions asked, while Chapter 6 (Sections 6.5.4.3 and 6.5.5.1) and Chapter 7 (Section 7.6.5.3) show the interview findings.

In analysing qualitative data, numerous techniques are used, of which the most commonly mentioned in the literature are: content analysis, conversation analysis, narrative analysis, qualitative comparative analysis and grounded theory [279-281]. This

research employed the most commonly used approach in qualitative research of discovering common themes in the gathered data via the thematic content analysis [282]. Given that the interviews performed in this research were guided by a set of questions, the main topics of the questions were used as the themes by which the interviewees' responses were categorised (see Appendix I).

4.3.3 Website interaction data

A data collection method commonly used in HCI research is automatic logging of system usage data [260]. The cross-sectional *data on user interactions with the PORT website* was logged on the website from Study 3 onwards, particularly after the implementation of the Emotion Tool and emotion-based personalisation (see Chapter 5). The logged data included emotion intensities self-reported by users, links users visited on the website, features clicked on (e.g. rating and sharing), data provided in editing the profile, and user feedback about the usefulness of content recommendations. Due to the sensitive nature of this data, participants in the last three studies were additionally informed that their activities on the website were tracked.

Website interaction data was particularly used in generating user models for content recommendations (i.e., use of machine learning models) and discovery of emotion-based adaptation rules via predictive data mining methods (Chapter 5, Section 5.3). Certain features from this data were also used in statistical analysis in response to RQ 2.1.1, specifically in inferential tests that explored the usefulness of content recommendations on PORT.

4.3.3.1 Longitudinal website usage data

Longitudinal data was extracted in Study 4 from website interactions logged on the PORT website (Phase III version; see Chapter 5). Appendix K provides a more detailed explanation of the longitudinal study, its methodology and findings.

Generally, longitudinal data is the most expensive and most difficult to obtain. Moreover, it provides more reliable understanding of user interactions with the system – the features they would use and prefer – as users familiarise themselves with the system over a longer period of use. Therefore, *a longitudinal study was performed for this research, and with the PORT version with emotion-based personalisation.*

Participants in the longitudinal study were selected by applying purposive sampling. These were *people who were directly or indirectly affected by cancer*, who were the younger segment of the population, more tech-savvy and more likely to use online health services. This group of participants had *previously used PORT website*, and thus represented *repeat website visitors*. Invitation to the study was sent to 30 people, including: participants from the previous studies who were willing to assist in future research, and also my acquaintances. *Nine people* responded and engaged in the longitudinal study. They *visited the PORT website for one month* from March to April 2016, once or twice a week, and interacted with it for 5-10 minutes per visit. Activities of the nine participants were logged at each website visit. The results of the longitudinal study are shown in Chapter 7 (Section 7.6.5.2) and Appendix K.

4.3.4 Evaluation of existing B&H and UK health-websites

Adopting the approach from a study assessing the quality of Spanish public hospital websites [283], I manually evaluated *15 health-websites from B&H and the UK* in Spring 2014 on the *availability of 24 personalisation features* (this study appears in detail in my publication in [284]). The types of features included: navigation, content, design, and adaptivity/adaptability.

The selection of health websites was based on search engine rankings and their reputation in the respective countries. The sample size was adjusted to the previous research which evaluated 12 Web-based health portals [102]. The selected B&H websites were: PORT (www.port.org.ba), Renesansa (www.renesansa.com.ba), Srce (srcezadjecu.ba), Biser (www.biser.ba), Zagrljaj (www.zagrljaj-mo.org), Novi pogled (www.novi-pogled.org), cancer-forum (www.klix.ba/forum/karcinom-i-borba-sa-njim--t26209.html) and

BHZdravlje (www.bhzdravlje.ba). The UK websites were: Cancer Research UK (www.cancerresearchuk.org), Macmillan Cancer Support (www.macmillan.org.uk), Action Cancer (www.actioncancer.org), Maggie's Cancer Caring Centres (www.maggiescentres.org), Marie Curie Cancer Care (www.mariecurie.org.uk), Prostate Cancer UK (prostatecanceruk.org) and Breast cancer care (www.breastcancercare.org.uk). Detailed results of the study are presented in [284], while Chapter 6 (Section 6.3) summarises the findings.

4.4 Experimental design

Experiments can generally be categorised into natural and quasi-natural [285], field and laboratory experiments [286]. In contrast to the other types, laboratory (i.e., controlled) experiments are performed in controlled setting [286], and follow standardised procedures; which means easier replication [286], as an important requirement in scientific research. The reviewed previous studies [32, 33], which evaluated personalised systems, generally used controlled experiments in labs. For all the named reasons, as well as due to limited resources (time, access to participants), controlled experiments with the PORT website were selected as the main approach in this thesis. In some of my studies, participants, who were inaccessible or unable to attend lab experiments, interacted with the PORT website and searched for cancer content from their real-life settings (e.g., their home). Thus, a form of field experiments, with prescribed procedures, was also adopted in this research.

All studies in this research, apart from Study 1, included an experiment with several versions of the PORT website, which were compared in terms of the personalisation they offered. HCI *experiments* can be designed as within-subjects or between-subjects [287, 288], depending on which conditions (i.e., system versions) the participant groups are exposed to. In this research, a *within-subjects* design was used in *Study 2, 4 and 5*, while *Study 3* was based on *between-subjects* design. Controlled experiments with within-subjects design were used in previous research, which also evaluated e-health website usability [11]. Both approaches have advantages and disadvantages.

In *between-subjects design*, all subject groups receive different instructions [288]. This approach allowed the participants to focus on a single website version; survey duration was shorter, hence, responses were not as susceptible to the effect of participant fatigue. However, in such conditions, there is a chance of differences between the groups – subjects in one could be more lenient than in the other [289]. Moreover, in evaluating the website, participants did not have a benchmark or a point of comparison to base their ratings on.

In *within-subjects design*, where all subjects are exposed to all the tested conditions [288], the order of conditions could have an effect; hence it is important to counterbalance or randomise the order of presentations [289]. Nevertheless, this design is better at detecting the independent variables' effect compared to the between subjects design [289]. *A within subjects design prevailed in this research due to the need to expose each participant to the various versions of the PORT website and obtain their explicit feedback on which of the options they preferred over others.*

The ***experiment procedure*** was distributed to participants along with the questionnaire. Generally, upon opening an online survey form, participants were first informed about the study and their rights, afterwards presented with a pre-use questionnaire for self-reporting emotions, which was followed by *the experiment instructions*, and finally with the post-use questionnaire consisting of the instruments for measuring the various research constructs (Appendix B).

An experiment procedure comprised a list of instructions about the activities and tasks to complete on a version of the PORT website. Attention was paid to assign labels to the website versions that would not influence participants' opinions or indicate the researcher's bias. *The experiments generally lasted 30 minutes; usage time for a single website version was around 15 minutes.* Short system usage time is not uncommon in the related literature. Conati et al. [54], for example, assigned 10 minutes for student interactions with an e-learning system. Similarly to the research presented in this thesis, Conati et al. [54] were restricted in time and had limited computer availability. Their

surveys were also divided into pre-use questionnaire, experiment with the system, post-use questionnaire. Moreover, they also collected self-reported emotions.

In all the studies of this research, a large portion of participants conducted the experiments on their own, without the researcher's *supervision*. These were participants recruited via online channels. They were able to e-mail the researcher for assistance and clarification. The other group of participants, mainly *students*, conducted the experiments in a laboratory or classroom setting, and *were supervised* by the researcher or a course lecturer. Outlines of the different experiments carried out for this research are next provided.

4.4.1 Study 2 experiment

Study 2 used a *within subjects design* with *no randomisation*. All participants used PORT's original Wordpress website, and the first version of the personalised PORT cancer website (Phase I version). The two websites were labelled *version 1* and *version 2*, respectively. It was attempted to avoid the effect of a label (e.g., 'old' vs. 'new') on users' perception about the websites. After interacting with the two websites, usability of version 2 was evaluated by comparing it to version 1 (see Appendix B). For example one of the eight items that measured usability stated: *I found the 2nd version of PORT's website more complex than the 1st version*.

The *experiment tasks* for both website versions were presented within the same section of the survey form. Approximately 10 minutes were prescribed to complete the tasks for each website version. Participants could choose which version to go to first, however, they were instructed to go to version 1 if they had not previously used it. Detailed *experiment instructions* are presented in Appendix D (Section D.1). They included: creating an account, reading the privacy policy, editing the user profile, using the search tool, reading an article and using the available features on the web page, using the virtual community – blog and forum, and reviewing activities on the profile.

4.4.2 Study 3 experiment

Study 3 used a *between subjects* design. Two independent participant groups were formed; both interacted with the PORT website developed for this research. *Group 1 (CG1)* participants – treatment group - completed 13 tasks on the *personalised version* of the PORT website [290] (Phase II version) and filled in a questionnaire within 1 hour. *Group 2 (CG2)* participants – control group - were instructed to visit the same PORT website [290], however asked not to register or login throughout the usage, hence experienced the website *without personalisation*. CG2 completed 8 tasks on the website, and with the questionnaire part, the overall duration of the experiment was 45 minutes.

The *experiment tasks* are presented in detail in Appendix D (Section D.2). They included: creating an account (only CG1); using the Emotion Tool⁷ (only CG1); reading the privacy policy (CG1 and CG2); editing the user profile (only CG1); using the search to find an article, reading it and using personalisation features on the article page (CG1 and CG2); viewing recommended articles (CG1 and CG2) and rating recommendation's usefulness (only CG1); using the virtual community (CG1 and CG2); viewing recommendations in the knowledge base (CG1 and CG2); visiting the user profile and reviewing changes in the content recommendations (only CG1); finally, freely browsing the website in the role of a person affected by cancer (CG1 and CG2).

4.4.3 Study 4 experiment

Study 4 was based on a *within subjects design*. Participants used three versions of the PORT website: **DEF** - the PORT website without personalisation, when a user is not logged in; **PRE** - the PORT website with generic personalisation (Phase II version, see Chapter 5); **EXT** – the PORT website with emotion-based personalisation (Phase III version).

⁷ On Phase II PORT website, the Emotion Tool did not pop-up automatically, but was present in the bottom left corner of all web pages, and expanded to full view on hovering over it.

Six control groups were formed depending on the order of website versions, with a relatively equal, randomised, distribution of participants. The experiment and questionnaire took around *90 minutes to complete*. The experiment included separate instructions for each of the website versions. The instructions were for the most part the same for all websites, to avoid or reduce the effect of experiment procedure on the participants. However, some of the tasks were not applicable to the DEF version.

The complete list of the Study 4 *experiment tasks* is provided in Appendix D (Section D.3). *11 tasks were assigned for PRE and EXT, and 6 for DEF*. Participants were instructed the following (if not stated otherwise, the task refers to all website versions): select website language; create an account and log in (only PRE and EXT); report emotions at login (only PRE and EXT); browse the website for 10 minutes (PRE and EXT) / 5 minutes (DEF) by taking the role of a cancer-affected person and use the Emotion Tool frequently (only PRE and EXT); log out and log back in (only PRE and EXT); research treatment options for a cancer issue by assuming the role of the same cancer-affected user; report emotions (only PRE and EXT); use the website for 5 minutes; pay attention to the user profile content and features (only PRE and EXT).

4.4.4 Study 5 experiments

Study 5 was divided into *three separate surveys*, each with a *different experiment* and unique participants. The aim was to *alleviate the limitations of the previous four studies* – to reduce the complexity of experiments by dividing them into several smaller ones, and hence *reduce the effect of participant fatigue*. All three experiments in Study 5 were carried out with the latest version (Phase IV version) of the PORT website (<http://port.org.ba>), with refined *emotion-based personalisation*.

In the **first experiment** participants used the 42 different personalisation-related features and 10 other features and content types available on the PORT website. They then evaluated the *usefulness* of the individual *features*. The estimated *duration of the experiment was 50 minutes*. This experiment was divided into several parts, each corresponding to a PORT website segment/page(s) (e.g., Articles, Blog, User profile,

etc.). As explained in Section 4.3.1, this was done not to overwhelm the participants with all the website features at once. Instead, a single part of the experiment (i.e., a section of a survey form) presented only a short list of features available on the particular website segment. The following is an example of *instructions for the features available on the Edit Profile* segment of the PORT website:

- a. Go to *Edit profile* from My PORT – Edit profile.
- b. *Select one of the colours / or default colour* for the website background.
- c. You can *enter your basic/background information*.
- d. You can *specify four types of cancer-related interests*: how cancer affected you, cancer type by gender or body part, and cancer information.
- e. Save the changes you made.

After the above instructions, participants evaluated the usefulness (-2: very useless to 2: very useful) of the following features:

- Option for *tailoring user profile*;
- *Defining personal interests*;
- *Information bubbles* (i) about each data field;
- *Tailoring website background* (colour or image).

The *second* experiment was based entirely on tracking *user interactions* with the latest version of the PORT website. Participants were instructed to *freely browse the website for five minutes* by taking the role of a cancer-affected person. The tasks are detailed in Appendix D (Section D.4.1)

The *third* experiment was the main objective of Study 5. It evaluated *user preferences for emotion-based personalisation on cancer websites*. *Within subjects design*, with *randomisation*, was applied. Two versions of PORT website were used:

- the latest version (Phase IV version) *with emotion-based personalisation (E)*,
- the version (Phase II version) *with generic personalisation, but not tailored to user emotions (P)*.

Two control groups were formed; one interacted first with version E, followed by P, while the other group first used P then E. The overall duration of the experiment was 30 minutes, with approximately *10 minutes usage time per website version*. After using a single website version, participants evaluated its *usability*. A *short break* between the two website versions was recommended to the participants.

At the end of the experiment, after experiencing both websites, participants were asked to *identify which website version they preferred* - “In your opinion, which of the two versions of the PORT cancer website has more appropriate personalisation services?”. Preference was measured using the **4-AFC questionnaire protocol** [179, 248]. 4-AFC allowed expressing a *preference for one of the website versions* over the other version, *equal preference* for both versions, or *equal dislike* (lack of preference) for both website versions. In user survey experiments which are based on self-reporting, this type of pairwise preference method was shown to have advantages over the ratings methods [291], e.g. using a Likert scale.

As in Study 4, the *experiment instructions* were presented *separately for each of the website versions*. Effort was again made not to differentiate between the website versions in terms of the number or type of experiment tasks. Hence, *11 tasks* were assigned for website version E, and *9 tasks* for version P. A detailed description of the Experiment 3 tasks is presented in Appendix D (Section D.4.2). These included (if not stated otherwise, the task refers to both website versions): selecting the website language; creating an account and logging in; searching for the article “Don’t believe the hype – 10 persistent cancer myths debunked”; rating the article with a high rating; reporting the intensity of the emotion *interest*, for the rated content (only E); visiting the user profile and reviewing content recommendations; logging out and back in; reporting the intensity of *interest* at login (only E); observing the changes in website appearance; visiting the user profile and reviewing the content recommendations.

4.5 Data pre-processing

The raw data collected via the various previously mentioned methods was pre-processed and cleaned before analysing it in one of the software tools used in this research. Unique cases of data cleaning were explained in Chapter 6 and Chapter 7, for the specific study.

Responses to *open-ended questions* and *interview data* were treated in the textual form using spreadsheets or word processors. They were coded using the multiple-response method [93], in which interviewees' responses were grouped by similar themes. *User generated content* extracted from online health services or survey participants' feedback, which was submitted in Bosnian, was translated into English. *Log data from the PORT website* was converted into separate variables with aggregated and unified values.

Questionnaire data was treated in Excel for outliers and missing values. *Outliers* were cleaned by: aggregating data for demographic variables, or replacing the value with the variable's mean. *Missing values* were present in all variables. They were mainly recorded in the statistical tool as a missing value, for example with a discrete value, either -1 or some other numeric value not appearing in the rest of the data. Due to the relatively small number of responses, an alternative method was replacement (with mean, or mode for categorical variables).

Only in rare instances was *discarding* used, for example the removal of cases which were entirely randomly answered. Post-experiment it was possible to *evaluate the responses received* in terms of: survey starting and ending time; comparing the number of survey responses received with the number of user profiles registered on the website; checking whether the activities performed for each user profile coincide with the defined tasks. If issues were noticed, the problematic data instance was reviewed thoroughly, and in some cases removed from the dataset. In Study 5, the evaluation experiments relied entirely on user interaction with the website. Hence, all user activities were reviewed to determine whether a user interacted with a feature/segment of the website. Only then was their response for that feature accepted. Otherwise, it was treated as a missing response.

4.6 Data analysis methods

With respect to the data analysis approach, research can be divided into hypothesis-driven and data-driven [251, 292, 293]. The growing availability of ‘big data’ has popularised the employment of data-driven research [292], where hidden patterns are sought in the data, without putting constraints of conventional approaches to what is being sought and how [293].

Hypothesis-driven approach is still the prevailing type of research [251], whereby existing scientific theories are used to form hypotheses that determine the type of findings looked for in the available data [293]. The fact is that data collection in scientific research is never really random, but rather is based on and limited by the available theories, methods, data collection instruments, and researchers’ experience and preconceived ideas [251]. Previous research has provided arguments for and against both approaches [251, 293]. It is evident from the previous research that a prerequisite for successful implementation of the data-driven approach is availability of large amounts of data [251, 292, 293]. The majority of personalisation-related studies [53, 151, 221, 295] that were reviewed for this research were hypothesis-driven, experimental research that evaluated their personalised systems by employing questionnaires, or other instruments for collecting explicitly reported data, from smaller samples of participants. Therefore, the hypothesis-driven approach, still considered the standard method [294], also prevailed in this thesis.

One of the main aims of this research was testing the applicability of relations found in other domains to the online cancer-support domain (e.g., the effect of personalisation on behavioural intentions). These relations were conceptualised in a research model and defined by the research hypotheses (Chapter 3). Understudied relations were explored using both hypothesis- and data-driven approach. However, limited number and accessibility of target users, numerous features and short interaction with the PORT website (most of the features were very rarely used), and users’ inclination to report only a few emotions, resulted in poor performance (i.e., low accuracy) of the data-driven machine learning models (see Chapter 7, Section 7.6.5 and Appendix N). Moreover, the

amount of data collected via questionnaires and website usage data was not sufficient for relying entirely on the data-driven approach. Therefore, data-driven explorations were only supplementary to the hypothesis-driven approach, which was more applicable to this research, given the time and resource constraints in which it was performed.

Relatedly, different methods for data analysis can be considered, including: descriptive statistics, inferential statistics, structural equation modelling (SEM), or machine learning as the more automated, data-driven approach to pre-processing and pattern discovery. This research has employed all the mentioned analysis methods, apart from SEM. The potential application of SEM is discussed in Chapter 9 (Section 9.3). Machine learning methods were applied to the website usage data. Machine learning models are an integral part of the PORT's content recommendations' algorithms (A1 and A2, Chapter 5), and were also used in generating the emotion-based feature adaptation rules (A3 algorithm, Chapter 5). Nevertheless, descriptive and inferential statistics were applied to the relatively small datasets, collected from experiments and survey questionnaires in this research. The statistical approach was used to test individual relations set by the predefined hypotheses. Indeed, with the collection of larger amounts of data, data-driven approach with machine learning methods could also be applied, to confirm the research model relations established in this thesis, and to discover new relations hidden in the data.

4.7 Summary

The main focus of this chapter was providing a detailed overview of the research design. The chapter covered the methods used in sampling, data collection and design of the controlled experiments. The next chapter introduces the PORT website. Chapter 5 overviews the methodology of the website's design and implementation. Moreover, it illustrates the website features and underlying algorithms, particularly the emotion-based personalisation applied to content recommendations and feature adaptation.

Chapter 5

PORT cancer website: Design and implementation

This chapter presents PORT.org.ba, the personalised cancer website developed for this research (RObj3 and RObj7). The chapter describes the phased approach to the website design and implementation and the development technologies used. It proposes algorithms for emotion-based personalisation and illustrates characteristic features and functionalities of the website through simulated user interactions.

5.1 Development framework

The development requirements for the PORT website - its design and appearance, features and functions, underlying algorithms and adaptation and personalisation rules – were extracted and defined by me, from the findings obtained in the five studies performed in this research. I additionally carried out all the feature testing, corrections and improvements. The website development itself was outsourced to a Web development company in B&H – **Website.ba** [296]. I decided for outsourcing in light of the project size, which spanned over four development phases and more than 18 development months. Moreover, the PORT website was intended for the PORT Association I collaborated with, and thereby for commercial use by real-life users. Hence, this was not only a research project. Furthermore, the Web development company from B&H was selected, after reviewing several options. Website.ba was an established business with a number of Web projects for respectable clients, it was familiar with the latest world trends in Web development, but also with the B&H context and language.

The *Symphony framework*⁸ was chosen for the development framework. As it is a model-view-controller framework, it is object-oriented, and is best for modular, iterative, parallel development. It contains different bundles, which enable fast development and maximum optimisation. This framework is optimal for larger projects, as was the

⁸ <https://symfony.com/>

development of the PORT cancer website, which was likely to have frequent changes in requirements. Symphony's additional advantage is that it supports migrating system development from one developer to another. The technologies the framework is based on are: PHP, CSS3 technology for design, HTML 5, jQuery JavaScript and MySQL database.

5.2 Phased design and implementation

This section presents the evolution of the PORT website through the four development phases. It shows the implementation and improvement of the different website features.

It was explained in Chapter 1 (Section 1.3) that the development of the personalised PORT cancer website resulted from collaboration with the PORT Association. The PORT Association originally had a simple Wordpress website⁹, which offered a virtual community (only an inactive forum) and a news portal, without any personalisation. Figure 5.1 illustrates the appearance of the Association's original website.

The design and implementation of the personalised PORT cancer website were founded in the *phased approach* and *user-centred method* [297]. The user-centred method caters to user needs and preferences, and thus increases the resulting system's performance in terms of usability, usefulness and user satisfaction [297]. Requirements gathering and system design relied heavily on user participation and feedback. The data collected through a number of interviews, questionnaires, experiments with the website, and website log data, enabled identifying target user preferences for personalisation services on the PORT cancer website.

Website development was carried out in *four phases*, as follows:

1. **Phase I** (July - September 2014): the first version of the personalised cancer website; it was based on traditional user profiling, majority of personalisation

⁹ The link to the original Wordpress version of the website was <http://www.port.org.ba/>. The domain is now used for the latest version of the personalised PORT website. The original website is not in use anymore.

features were introduced and semi-personalised content recommendations provided.

2. **Phase II** (November 2014 - March 2015): the second website version; personalised recommendations based on filtering techniques and Emotion Tool were introduced.
3. **Phase III** (October 2015 - March 2016): the third website version; emotion-based personalisation was introduced – website features adapted and content recommendations personalised to user emotions.
4. **Phase IV** (May - September 2016): Website refinements; adjustments to the website features and personalisation/adaptation rules were made.

Requirements for **Phase I of website development** were extracted from Study 1 findings on target users' desired personalisation features, type of personalisation lacking on existing health websites in B&H and the UK, and the most popular cancer topics on the Web (details are provided in my publications in [284] and [298]). Consequently, *Phase I* encompassed:

- *developing the website from scratch* – this was justified in Chapter 1, Section 1.3, the primary reason being that existing cancer websites do not provide emotion-based personalisation, and other reasons were to: have ownership over the code, have access to all website functionalities, adopt the desired and reliable development framework, explore introducing innovative features related to adaptation and personalisation, and experiment with new parameters, such as user *emotions*;
- *organising the content* into four main content types – explained in the next section;
- *migrating the content* from the original to the personalised website;
- *introducing more modern, streamlined design and layout*, in comparison to the initial design of the Wordpress website, and in agreement with the PORT Association, while preserving their online identity - specifically the logo colours (purple and white);
- *implementing the 24 personalisation features* that were identified in Study 1 as desirable (see details in [284] and overview in Chapter 6, Section 6.3);

- *placing the new website on a temporary domain*, while preserving the original website on the port.org.ba domain (used for the controlled experiment in Study 2, see Chapter 4, Section 4.4.1).

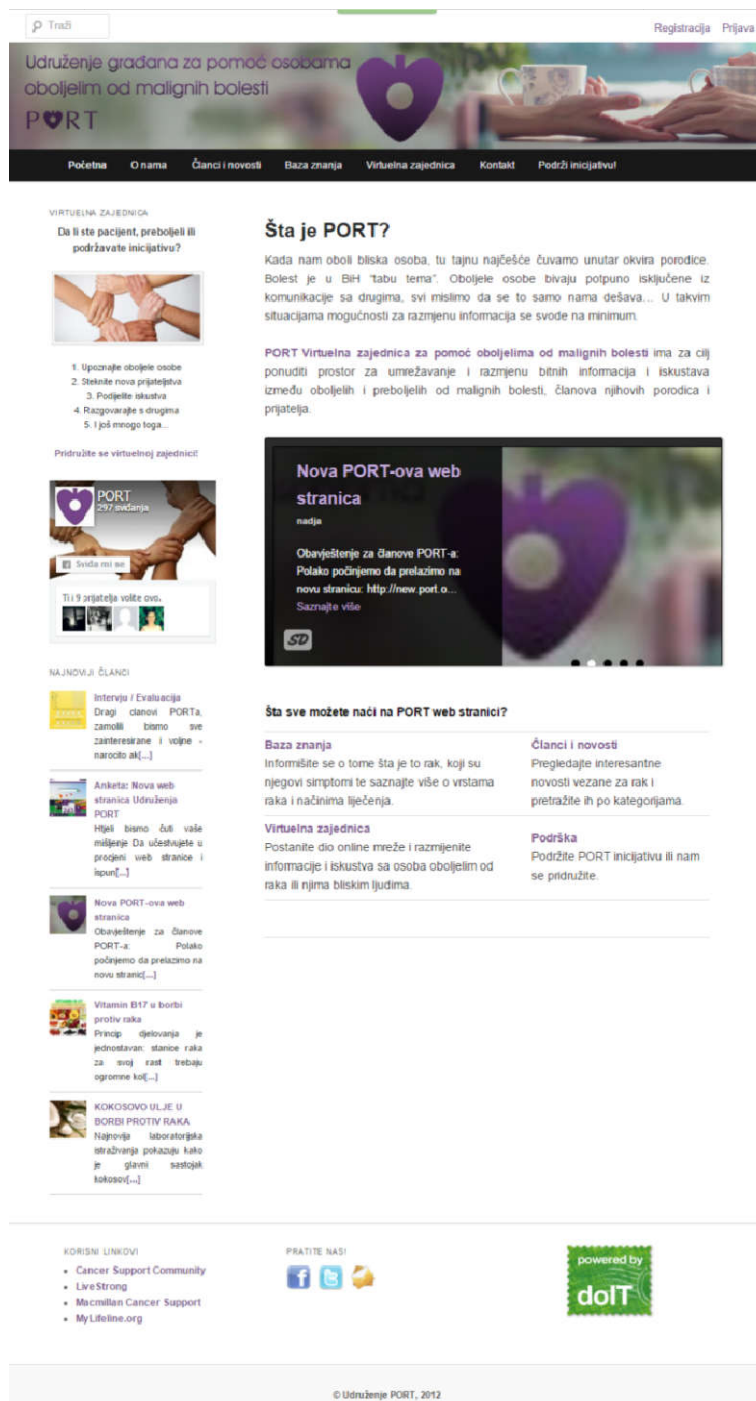


Figure 5.1. Appearance of PORT’s original Wordpress website

Phase II of website development resulted from user evaluations of the Phase I website. Thus, additional features were implemented and previous features improved. The first emotion-related feature was implemented - the Emotion Tool - as a step toward introducing emotion-based personalisation in the later development phases.

In ***Phase III of website development***, *emotion-based personalisation* was introduced. One of the main findings of Study 3 was that discrete emotions experienced at the start of website use influenced preferences for certain personalisation features (Chapter 7). These results were used to create a set of *rules for emotion-based adaptation* and *emotion-based content recommendations* that were implemented on the Phase III website version. The process of emotion-based personalisation is explained in detail later in this chapter (Section 5.3). Moreover, new features were introduced (e.g., chatroom) or improved (e.g. Emotion Tool).

Study 4 confirmed that emotions predicted which personalisation features a user preferred (Chapter 7, Section 7.6.5.1). The findings coincided with some of the Study 3 correlations, but also implied new *emotion - feature* relations. Hence, the main objective of the ***last phase of website development – Phase IV*** - was *refining the emotion-based features* on the PORT website. Additionally, other improvements were made such as: fine-tuning the website design and adjusting the type and weight of parameters used in generating content recommendations.

5.2.1 Website content structure

The PORT website developed for this research is organised around four main content types, based on the structure of the PORT Associations initial website. These are: *articles* (news articles), *knowledge base* (articles focusing on general, factual, cancer information), and user generated content in the *virtual community* comprising - *blogs* and *forum*. The user's private part - *My PORT* - was added to the website developed for this research. *My PORT* comprises *user's profile* page, *editing user profile*, *messages*, and *managing the content* they posted on the website. Additionally, the website introduced a *Privacy Policy* page with personalisation features and a *Chatroom*, which the PORT

Association suggested was desired by its members. The static segments (referred to here as *general* content) were also adopted from the Association' initial website, and are the About PORT, Terms of Use and Support (Donate) pages. Figure 5.2 presents the Home page and the general appearance of the latest (Phase IV) PORT cancer website.

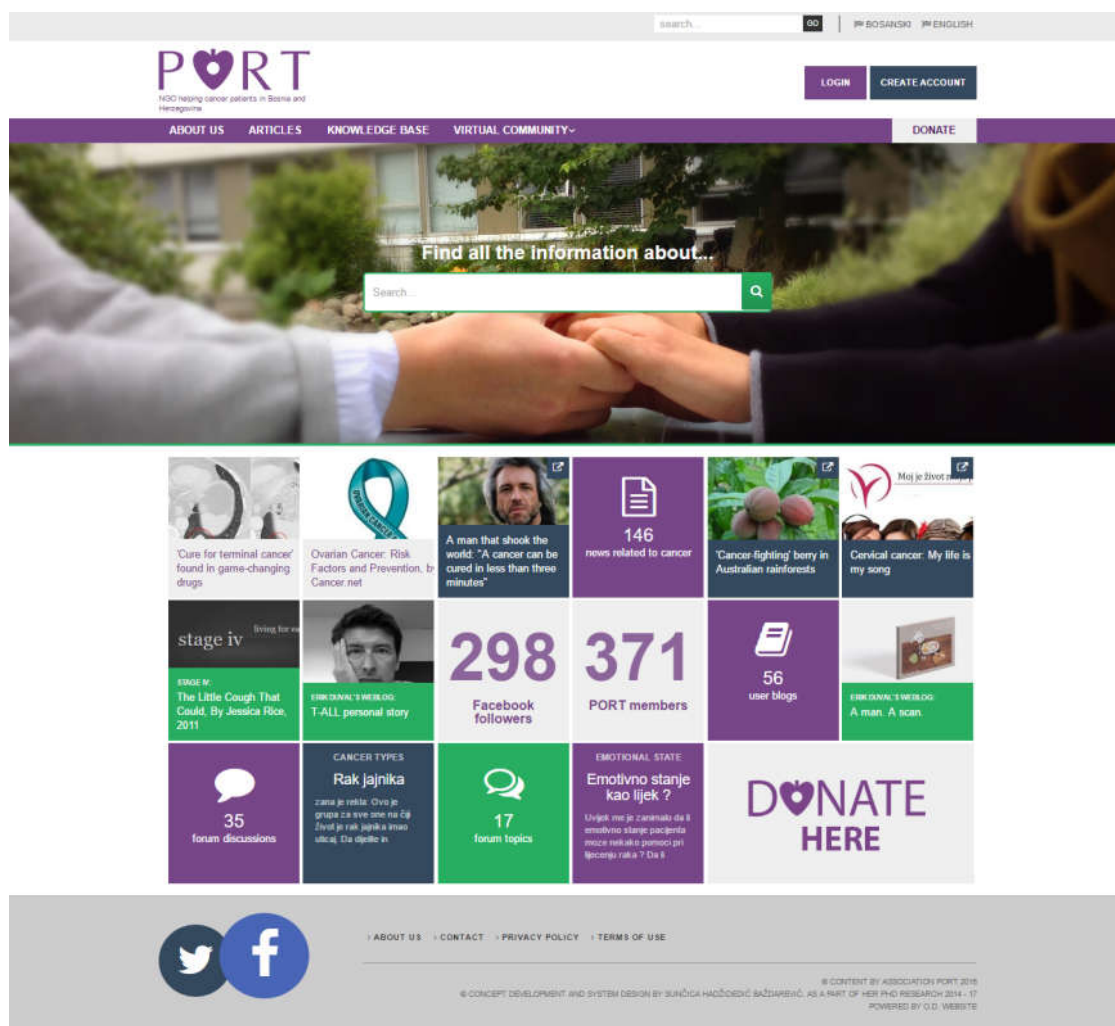


Figure 5.2. Appearance of the latest version of the personalised PORT website

5.2.2 Interests

The content on the PORT website is indexed by *content categories* (14 categories, e.g., research, cancer types, diagnosis, etc.) and/or *interests* the content addresses. *Articles* are *classified using both criteria*, while *blogs, forum and knowledge base content* is *indexed*

only by interests. Website administrators index articles, knowledge base and forum topics at every new adding of content, while users themselves classify the content they are enabled to create, which are blogs.

Indexing content by interests was introduced in this research for the purposes of personalising content, i.e., generating content recommendations that reflect user's cancer-related interests (next explained). PORT Association's original website classified articles, as their main content type, into the previously stated categories of cancer topics, for easier search. The categories from the initial website were adopted on the here-developed website, as an additional parameter used in articles' personalisation.

Previous research [299] was used to identify the different groups of interests, particularly the types of cancer information. Additionally, one of the pilot studies in this research explored the topics of discussion on a cancer forum used in B&H (see my publications in [298] and [284]). The popular cancer topics in B&H and the online cancer information most frequently sought on the Internet were combined to form the *12 types of cancer information used on the PORT website*. These are:

- Alternative treatments or medicines
- Diet/nutrition/nutritional supplements
- Information on a particular doctor or hospital treating certain types of cancer
- Experimental treatments or medicines
- Gathering information before visiting a doctor
- Personal stories of people in a similar situation
- Prescription or over-the-counter drugs
- Certain medical treatment or procedure
- Specific cancer type or cancer-related medical problem
- Sensitive cancer-related topics that are difficult to talk about
- Consequences of cancer and cancer treatment
- Exercises and fitness.

Moreover, as this research focuses on cancer services for different categories of cancer-affected people, it was necessary to classify the website's content based on the audience

it was intended for. Finally, as this is a cancer website, one of the most important aspects to classify its content by was the type of cancer it addresses. Two general cancer-type classifications – by gender and by body part (organ or tissue) – were adopted from [300, 301].

Hence, all the content types on the PORT website are indexed by four groups of *interests*: *effect of cancer* - whether the content reflects interests of a cancer patient, an indirectly affected user, or a user generally interested in cancer information; *cancers by gender* – whether the content addresses male or female cancers; *cancer types* – which of the 58 different cancers are covered by the content; and *type of cancer information* it provides (12 categories, from treatments and diets, to personal stories and doctors/hospitals).

User profile customisation

☒ Type of cancer-related information you would like to have offered on this website
 ☐ CHECK ALL

Alternative treatments or medicines	<input type="checkbox"/>	Diet/nutrition/nutritional supplements	<input checked="" type="checkbox"/>
Information on a particular doctor or hospital treating certain types of cancer	<input type="checkbox"/>	Experimental treatments or medicines	<input checked="" type="checkbox"/>
Gathering information before visiting a doctor	<input type="checkbox"/>	Personal stories of people in a similar situation	<input checked="" type="checkbox"/>
Prescription or over-the-counter drugs	<input type="checkbox"/>	Certain medical treatment or procedure	<input type="checkbox"/>
Specific cancer type or cancer-related medical problem	<input type="checkbox"/>	Sensitive cancer-related topics that are difficult to talk about	<input checked="" type="checkbox"/>
Consequences of cancer and cancer treatment	<input type="checkbox"/>	Exercise and fitness	<input checked="" type="checkbox"/>

Content indexing

THE ARTICLE ADDRESSES WHICH OF THE FOLLOWING TOPICS?
 ☐ CHECK ALL

Alternative treatments or medicines	<input checked="" type="checkbox"/>	Diet/nutrition/nutritional supplements	<input checked="" type="checkbox"/>	Information on a particular doctor or hospital treating certain types of cancer	<input checked="" type="checkbox"/>
Experimental treatments or medicines	<input checked="" type="checkbox"/>	Gathering information before visiting a doctor	<input checked="" type="checkbox"/>	Personal stories of people in a similar situation	<input checked="" type="checkbox"/>
Prescription or over-the-counter drugs	<input checked="" type="checkbox"/>	Certain medical treatment or procedure	<input checked="" type="checkbox"/>	Specific cancer type or cancer-related medical problem	<input checked="" type="checkbox"/>
Sensitive cancer-related topics that are difficult to talk about	<input checked="" type="checkbox"/>	Consequences of cancer and cancer treatment	<input checked="" type="checkbox"/>	Exercise and fitness	<input checked="" type="checkbox"/>

Figure 5.3. *Type of cancer information*, as one of the interest categories

To match the content with user preferences, users provide their personal information on the *edit profile* page. The following type of data is collected: *demographic information*, including gender, age, country of residence; *website appearance preferences*, including favourite colour, website background colour or image, profile image; and *user's cancer-related interests*. The same *four groups of interest categories* appear in *user profile customisation*. In addition to specifying how they were affected by cancer, whether male or female cancers interest them, and the individual cancer types, users also select from among the 12 types of cancer information that interest them. Figure 5.3 illustrates how this feature is implemented on PORT website - on the *edit profile* page (top) and in *indexing content* (bottom).

5.2.3 Website features

The latest PORT website offers more than 30 types of personalisation features, which were adopted from comprehensive studies on adaptive hypermedia [75, 80, 88] and Web-based personalisation [17, 77], as reported in Chapter 2 (Section 2.3). This section presents the website features by the development phase they were implemented in.

5.2.3.1 Phase I

In the Phase I version of the personalised PORT website, 24 personalisation features were implemented. These were: (1) background tailoring, (2) user profile customisation, (3) adaptive navigation: links sorting and (4) direct guidance, (5) search outcomes presentation, (6) adapting text size and (7) colour, (8) notifications for activities and required actions, (9) content matched to user's personal interests, (10) content variety: visual/audio/text, (11) content in native language (bilingual), (12) blogging, (13) use of forum discussions, (14) greeting with user's name, (15) forum discussions' recommendations, (16) blog topics' recommendations, (17) articles and news' recommendations, (18) bookmarks (readlist), (19) sharing content, (20) ratings, (21) commenting, (22) matching content based on popularity, (23) categorising content and

(24) personalised e-mail notifications. Figure 5.4 illustrates an *article* page and the *features* available on it, including the features: 6 - 11, 14, 17 - 20 and 23.

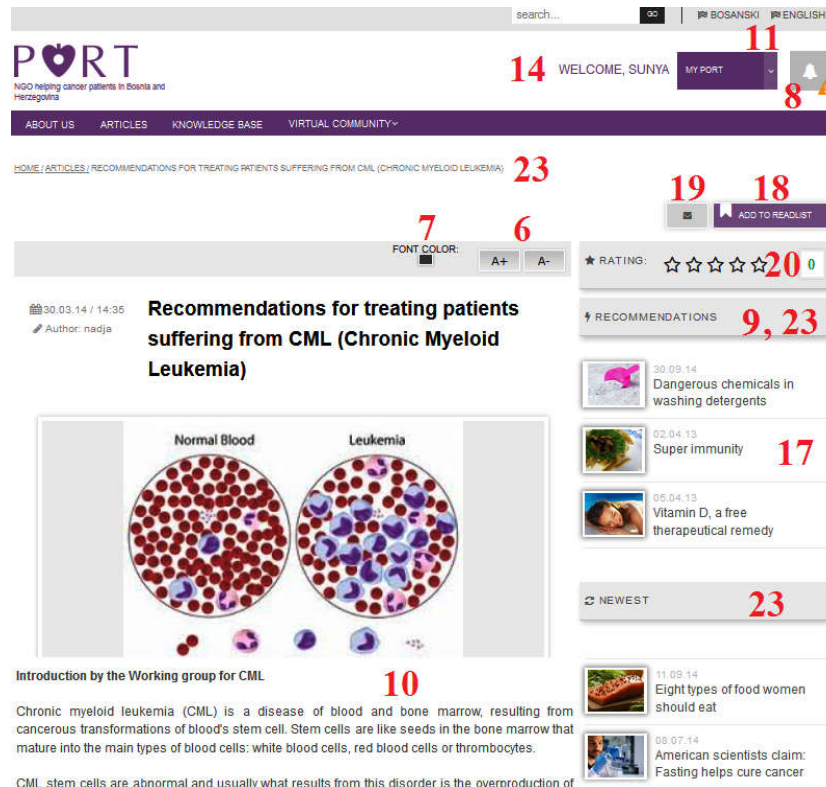


Figure 5.4. Appearance and personalisation of the Phase I PORT website

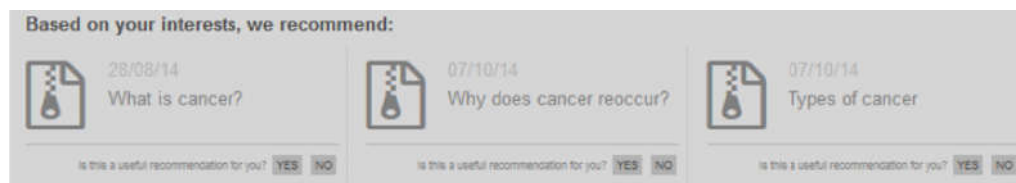


Figure 5.5. Semi-personalised content recommendations - Phase I

The majority of these features were adopted from previous literature [17, 75, 77, 80, 88], as previously explained, or were based on the features available on online services with advanced level of personalisation, for example in e-commerce – Amazon.com¹⁰ – and in entertainment – Netflix¹¹. These features were first evaluated in Study 1 to establish

¹⁰ <https://www.amazon.com/>

¹¹ <https://www.netflix.com/>

which are desired and which are disliked by target users (see [284] and Chapter 6, Section 6.3). Moreover, existing health websites were reviewed to identify the type of features they commonly provided and lacked (see [284] and Chapter 6, Section 6.3). Based on these findings, the initial set of the above listed 24 features was identified for implementation on the first version (Phase I version) of the PORT website. The initial set of features consisted of the basic features which enabled personalisation (e.g., 2) or website adaptation (e.g., 1), features providing the essential type of content personalisation (e.g., 15-17), as well as other general features (e.g., 10, 12, 19, 21 and 23) which nevertheless offered a more personalised feel or added to the website interactivity. The initial set of features was expanded and refined in the next phases of development.

Furthermore, *semi-personalised content recommendations*, based only on user interests, were introduced in this development phase. The cancer-related interests users defined within their profiles were used to filter content. Interest-matching content was recommended to users. However, no other parameters (e.g., user ratings) were considered at this stage; moreover, the extent of similarity was not accounted for in determining which content will first be recommended. These were, thus, semi-personalised recommendations. Figure 5.5 shows an example of knowledge base recommendations displayed on the main page of Knowledge Base.

5.2.3.2 Phase II

In **Phase II** of the website development, two distinguishing features were implemented - the *Emotion Tool* and *personalised content recommendations*. At this stage, personalisation was extended to other parameters of the user profile, including user background characteristics and content preferences (ratings). Thereby, to stimulate users to complete their profile information and to rate content they viewed, the following features were implemented: various *notifications* about user actions on the website or data missing in user profile (e.g. *red rectangle*, *orange triangle*) and reminder to rate read content (*What did you think about the following content?*).

To introduce an additional level of adaptation, the following features were introduced: *adaptation to favourite colour* (*adaptivity* - automatically adapting website background colour when a user selects their favourite colour, or *adaptability* - manual selection of the website background colour); and *privacy policy adaptation* (selecting the presentation of a long or concise version of privacy policy). Moreover, based on the trends in other personalised online services, e.g. Netflix, users were enabled to provide feedback about the usefulness of recommendations (*Is this a useful recommendation for you?*). Thereby, the feedback was used to additionally filter recommendations – recommendations which users did not consider useful were not presented to them anymore. The named features, along with other features available on the latest version of the PORT website, are illustrated in Appendix E.

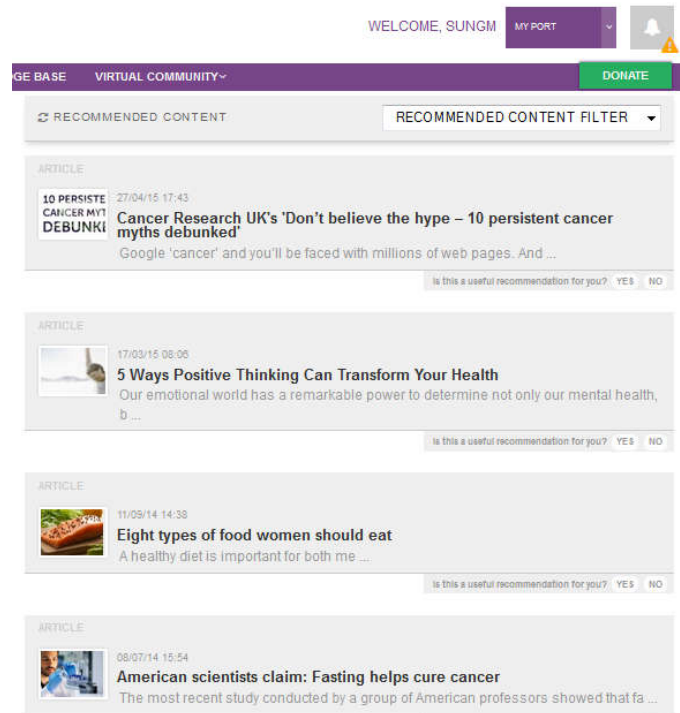


Figure 5.6. Content recommendations on the user profile page - Phase II

This phase also introduced the use of filtering techniques for personalised content recommendations. *Content filtering* was used for ‘existing’ users – users who have read and rated a certain amount of content on the website. The *k*NN algorithm was used to recommend the content which was the most similar to the user's preferred content (see Section 5.3.1.1, A1.1). *Collaborative filtering* was applied for *new website users*. In this

phase, similarity between a new user and the website's 'existing' users was based on – user demographic characteristics and cancer-related interests. Existing users' behaviour (i.e., content viewed and ratings) was also recorded on the website; however, it served to determine the content which would be recommended to the new user. Figure 5.6 illustrates the presentation of content recommendations on the Phase II website version.

5.2.3.3 Phase III and IV

The main improvement to the Phase III and Phase IV PORT website versions was introduced via the *emotion-based personalisation*. The rest of the sections of this chapter are dedicated to presenting the PORT website with emotion-based personalisation developed in these two phases.

Some website features and content evolved from Phase I to Phase IV, some were excluded, as the target users did not find them useful, and others were newly introduced. The complete list of personalisation features available on the latest version of PORT website and snapshots illustrating them are provided in Appendix E.

5.2.3.4 Emotion Tool

One of the *essential features for the implementation of emotion-based personalisation* was the *instrument for measuring emotions*. As explained in Chapter 2 (Section 2.4.3), Chapter 3 (Section 3.3.2) and Chapter 4 (Section 4.3.1.2), the **Emotion Tool** enables *self-reporting the intensity of all or any of the discrete emotions the tool presents, throughout the visit to the PORT website*.

The Emotion Tool was first implemented in Phase II. It was designed as a dialog box which is permanently present on the website in its contracted form – a small yellow square with an emoticon, placed in the lower right-hand corner of the website (Figure 5.7 – left). In its expanded form (Figure 5.7 - right), it listed the 12 discrete emotions explored in Study 3. Intensity of an emotion was reported using a slider represented by a heat-like filler and a number scale ranging from 0 to 5.

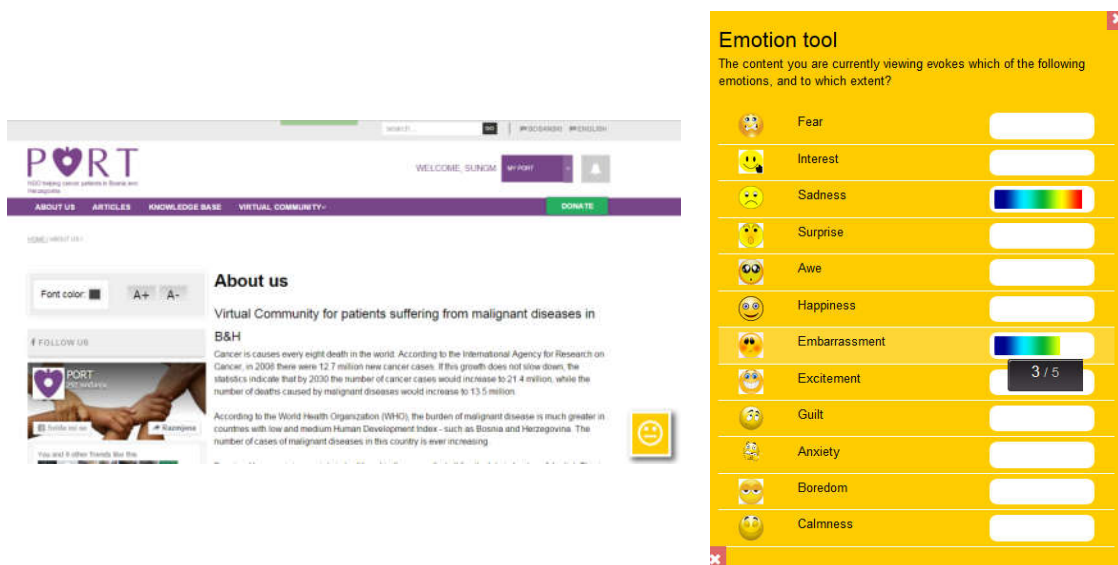


Figure 5.7. Emotion Tool on PORT website - Phase II version

The Emotion Tool was redesigned in Phase III. The same design was used in Phase IV, however, the intensity scale was adjusted - the range was changed from 1-5 to 0-4 (explained in Chapter 4, Section 4.3.1.2). The latest Emotion Tool enables users to subjectively report their affective state, by *selecting the intensity of all or any of the 9 listed discrete emotions*. Radio-buttons represent the number *scale for intensity*, ranging from 0 = *not at all*, 1 = *mildly*, 2 = *moderately*, 3 = *very*, to 4 = *extremely*. Next to each emotion name is an emoticon illustration (illustrated by me) of a (likely) facial expression, when in such an affective state. The emoticons are based on Ekman's [302] classification of facial expressions of basic/universal emotions. As with the previous version, the latest *Emotion Tool* is also permanently present in the contracted form in the upper corner of the website. However, the icon was redesigned to open only on a click, as website evaluations indicated users disliked the automatic expansion of the tool.

The latest Emotion Tool also *pops-out automatically* at two triggering events – *after the user logs into the website*, and *at every content rating*. The tool that appears after login has the following *instructions*: “Which of the following emotions are you currently experiencing? This will enable us to provide you feature and content recommendations tailored to your emotions.” The tool that appears after rating states: “Which of the following emotions were evoked by the website content/features you have just viewed?”

(Figure 5.8). Apart from the different instructions, the appearance of the Emotion Tool is the same.

It is possible that users did not notice the difference in the instructions. Nevertheless, essentially the same is asked of users – to report on the emotions they are experiencing at that particular moment. These can be emotions the user felt at the start of website use, i.e., when the login Emotion Tool appeared, or the emotions evoked by the content they rated, i.e., emotions reported via the Emotion Tool triggered by rating.

The website content/features you have just viewed evoked which of the following emotions?

	Not at all		Moderately		Extremely
Sadness	0	1	2	3	4
Fear	0	1	2	3	4
Shame	0	1	2	3	4
Joy	0	1	2	3	4
Anger	0	1	2	3	4
Guilt	0	1	2	3	4
Surprise	0	1	2	3	4
Interest	0	1	2	3	4
Disgust	0	1	2	3	4

Save

Figure 5.8. Emotion Tool on PORT website – Phase III and IV version (triggered by content rating)

5.2.3.5 *Why recommended?*

Another emotion-related feature introduced in Phase IV was *Why recommended?* - a typical expert systems feature, allowing the user to comprehend the actions of the system. This triggers an *explanation of why that specific list of recommendations was shown to the user*. This feature is available on all the *pages where content recommendations* are displayed, including the *user profile* page, at the top of the main pages of *all content types* – articles, knowledge base, forum and blogs, and within the content page – e.g. upon opening an article.

The message of the feature changes depending on the *aggregated affective state* which is reported at *login*, as it affects the generation of recommendations (explained in Section 5.3.1 of this chapter). Hence, if a user mainly reports positive emotions of a high intensity, the message in the *Why recommended?* feature reads (Figure 5.9):

*These recommendations reflect your emotions. You reported at login you were in a **positive affective state**. During your previous visits to the website, you gave high rating to a similar type of content when you mainly experienced intense positive emotions.*



Figure 5.9. *Why recommended?* for positively valenced aggregated affective state

If a user reports at login more intense negative emotions, the message will consequently display: “*You reported at login you were in a negative affective state*”. Alternatively, if negative and positive emotions are reported with the same intensities, the same explanation will be provided, however for a *neutral aggregated affective state*.

The next section details the main features introduced in the Phase III and IV versions of the PORT website. These are emotion-based adaptation and content recommendations algorithms.

5.3 Implementation of emotion-based personalisation on the PORT website

This section presents the algorithms for content recommendations and feature adaptation modelled from the findings on correlations between emotions and personalisation features, available in Appendix M and Chapter 7 (Section 7.6). The design of three

emotion-based algorithms is proposed. Algorithms A1 and A2 address the generation of *content recommendations personalised* to users' *aggregated affective state*. A1 is based on content filtering and is used for existing users, while A2 applies collaborative filtering techniques for new website users. The third algorithm, A3, is the proposed implementation of emotion-based rules for *website adaptation*.

5.3.1 *Emotion-based recommendations*

There has been extensive research on emotion-based recommendations [48, 49, 52, 186], particularly in the area of context-aware recommenders. Previous research has shown that incorporating the emotions' context when generating recommendations significantly improves the predictive performance of the algorithm, compared to the case where only non-emotion-related contexts are considered [186]. Some emotions studied here – sadness, fear, anger, disgust, interest, joy, surprise – have also been explored in context-aware recommenders [186].

The findings of this thesis showed that *emotions* stimulate cancer information seeking (see [284] and Chapter 7, Section 7.5) and influence how useful users perceive website content and features (Chapter 7, Section 7.6). Consequently, a **rule** is proposed here:

the content that is recommended to a user should reflect their emotions.

5.3.1.1 *A1: Algorithm for generating emotion-based content recommendations for existing users*

The **A1 algorithm** (Figure 5.10) applies to users (labelled here as an '*existing*' user) for whom their preferred content (the content the user read and liked – given a high rating) is known. The data provided at login triggers checking if the user has previously read and rated any website content, and determining the *average content rating* (A1: step 3).

The function *GeneratePreferredContent* (A1: step 5) takes as input user's *average rating* and the rating of each item of content the user has read and rated. If the *rating of the content* (item of content) is *greater than or equal to the user's average rating*, that content is recorded as a *preferred content*. An alternative to calculating the average rating would have been to use a fixed threshold. However, fixed thresholds may result in no recommendations, while this approach ensures that even if users have predominantly high (or low) ratings, they still receive content recommendations. Average ratings were adopted here as one of the possible approaches for recommender systems [303].

A1. Emotion-based recommendations algorithm: Existing user

Input: user log-in data, user emotions at login, user content ratings, user emotions at content ratings, content classification data (75 interests and 14 categories)

Output: recommended of different content - articles, blogs, knowledge base articles, forum discussion - on user profile page, and content-type specific recommendations on the pages of that content type (e.g., article recommendations on the Articles' main page and upon opening an article)

```

1. for each log in do
2.   aggregated_affective_state = AggregatedAffectiveStateAtLogin(emotion_intensity)
3.   average_rating = AverageRatingOfReadContent(content_rating)
4.   if (average_rating > 0) then
5.     preferred_content = GeneratePreferredContent(content_rating, average_rating)
6.     content_not_read = FilterByInterests(RemoveReadRatedContent(), user_interests, content_interests)
7.     if aggregated_affective_state == NULL then go to step11 to generate content recommendations
8.     else
9.       rating_aggregated_affective_state = AggregatedAffectiveStateAtRating (emotion_intensity)
10.    preferred_content = FilterPreferredContent(aggregated_affective_state,
        rating_aggregated_affective_state)
11.    for each preferred_content do
12.      generate content_recommendations
13.    end for
14.    FilterRecommendations(content_recommendations);
15.    print content_recommendations
16. end for

```

Figure 5.10. Emotion-based recommendation process for ‘existing’ users (pseudo code)

When the algorithm determines the user is an existing user, it also triggers identifying the content the user did not read, by applying the function *RemoveReadRatedContent()* (A1: step 6). The content that has not been read *content_not_read* is filtered to reflect user interests via *FilterByInterests()*. This function looks at the interests specified in the user profile and compares them to the interests that each *content_not_read* addresses. The function performs the comparisons at the interest category level.

As explained earlier in this chapter (Section 5.2.2), there are four *categories of interests*, and each category consists of a number of options (i.e., interests). There are in total 75

interest options. The *content previously not read* by the user has to match at least one of the interest options the user selected at each interest category level, to be included in the list of *content_not_read*. Otherwise, the content item is removed.

For example, the interest category *cancer types by gender* has two options – *female cancers* and *male cancers*. A user could select both female and male cancers. To be considered for recommendations, every content item the user has not read, should for this category address the topic of either male, female, or both cancer types. Also vice versa; if the user selected only female cancers at this category level, and the content item addresses both cancer types, it is included in *content_not_read*. However, if the content addresses only male cancers, but not female, it will not be considered for a recommendation. A content item has to reflect user interests for all four interest categories, otherwise if it does not match user interests in at least one of the categories, it is excluded from the *content_not_read*.

Equations 2 and 3 show the calculations used to identify whether a content item should be included into the *content_not_read*. CNR is *content not read*, SIC is *same interest category*, i.e., the interest category for which content and user interests match, and IC is the total number of interest categories (in PORT website's case IC is 4).

$$CNR = \frac{\sum_{i=1}^{IC} SIC(i)}{IC} = \begin{cases} 1; & \text{add to list of content not read} \\ < 1; & \text{remove content item} \end{cases} \quad (2)$$

In order to obtain CNR, Equation 3 is applied for every interest category. Whereby, NMI is the *total number of matching interests*, MI are *matching interests* and I is the *number of interest options (i) within the interest category*. SIC is also assigned 1 if, for that interest category, the user and content do not have any interest options selected.

$$NMI = \sum_{i=1}^I MI(i) = \begin{cases} \geq 1; & SIC = 1 \\ 0; & \text{remove content item} \end{cases} \quad (3)$$

A1 next checks if the user reported their emotions (step 7). The function *AggregatedAffectiveStateAtLogin* (used in both A1: step 2 and A2: step 6) accepts the intensity of emotions a user reported at login via the *Emotion Tool* (Section 5.2.3.4). The

function determines the valence of the user's *aggregated affective state* (Equation 5), first by calculating two variables representing the *mean intensity of negative emotions* and that of *positive emotions*.

As explained in Chapter 3 (Section 3.3.2), the nine emotions studied here have been classified based on their valence – positive and negative. Hence, interest and joy are marked as positive emotions, while the remaining seven emotions (e.g., fear, sadness, etc.) as negative emotions. The two categories of emotions were used to measure the respective factors of the conceptual framework (Chapter 3). Thereby, the two variables of the algorithm correspond to the factors – *negative emotions mean intensity* and *positive emotions mean intensity* – and reflect the findings for these factors (Chapter 7).

The valence of each discrete emotion is pre-recorded in the system. Thereby, $AIE(v)$ - the average intensity of emotions of positive or negative valence v - is calculated as below (Equation 4), where: $NE_v = \#Ei$ is the number of emotions of that valence reported by a user, $I_v(Ei)$ is the intensity of emotion i , and v is the valence of the emotion (positive or negative). For example, the *average intensity of positive emotions* (i.e., *positive emotions mean intensity*) would be the sum of intensities reported for *interest* and *joy*, divided by the number of positive emotions the user reported, which could be two or less.

$$AIE(v) = \frac{\sum_{i=1}^{NE_v} I_v(Ei)}{NE_v} \quad (4)$$

It should be noted that NE_v only counts reported emotions. It is assumed that if a user *did not report a specific emotion*, it is not that the user *did not experience* the emotion *at all* (which would be reported as intensity 0), but rather that they missed to reported it (i.e., *missing response*), and as such should not be counted toward calculating the aggregated affective state. The average intensities of positive and negative emotions are used to determine the overall *valence of the aggregated affective state* S of a user, as follows (Equation 5):

$$S = AIE(positive) - AIE(negative) = \begin{cases} > 0; \text{state} = \text{positively valenced} \\ < 0; \text{state} = \text{negatively valenced} \\ 0; \text{state} = \text{neutral} \end{cases} \quad (5)$$

Generating *emotion-based recommendations* is possible *only if the user provided their emotions* at login. This is the current design choice – content recommendations are generated at login, and only login emotions are used to filter them – while optimisation should be considered in future research. If the login emotions were not reported, *all the content* the user *preferred* in the past is used to generate *non-emotion-based* recommendations (A1: step 7). Otherwise, the user’s *preferred content is filtered* based on the *login emotions* and the *emotions reported at content rating* (A1: step 10).

Pre-filtering, one of the three approaches [304] used in the development of context-aware recommenders [186] was adopted for the emotion-based recommendation algorithms in this research. This approach uses a context-based condition – in this case emotions – to filter the list of content items (preferred content) [186]. Thereafter, the filtered items matching the given context are used in generating recommendations [186].

If a user rated any content *during previous visits* to the website, every rating activity automatically triggered the Emotion Tool to appear (Section 5.2.3.4, Figure 5.8), which prompted the user to report the emotions the rated content evoked. Hence, at each rating activity, the function *AggregatedAffectiveStateAtRating* (A1: step 9) assigns for *each item of rated content* the user’s *aggregated affective state* (if it was reported). The *aggregated affective state at rating* is calculated in the same way as at login (Equation 4 and 5). However, note that content recommendations are generated at the start of a website session, i.e. triggered by the user login. Therefore, rating activities that occur during the current website session affect content recommendations generated for the next website visit. Hence, in calculating content recommendations during the current website session, the *aggregated affective states at rating* are those that have been recorded in the system during previous visits to the website and previous rating activities.

Next, the *preferred content is filtered*, based on the two *aggregated affective states* – at *rating* and at *login*, via the function *FilterPreferredContent()* (A1: step 10). The selected items of preferred content are then used to determine the most similar unread content to be recommended to the user, as explained in the rest of the algorithm. The *FilterPreferredContent()* function extracts only the preferred content for which the user’s

aggregated affective state at rating (recorded for previous website sessions) matches the *login aggregated affective state* (reported at the beginning of the current website session). In other words, if the user reported at login intense negative emotions, i.e., a negatively valenced aggregated affective state, the function will select only those items of the preferred content for which the user reported predominantly negative emotions while rating those content items at previous visits to the website.

The *argument* here is the following. As emotions are rapidly changing states, the affective state changes during website use, particularly as a result of reading website information or interacting with website features. Hence, when rating an item of content, it is very likely that user's affective state would not be the same as the one they reported at login. Therefore, the system prompts the user to additionally report their emotions at every rating, as the emotions reported at rating are the most likely emotions the user is experiencing as a result of the content they have read; in other words, the emotions resulting from the level of satisfaction with the content, how well it met their needs. Furthermore, if a user rated a piece of content with a high rating (above their average rating), it can be assumed they like that type of content. However, the emotional context has to be taken into account. They like that content while experiencing a specific set of emotions, i.e., when in a certain affective state.

Let us presume the user mainly experienced negative emotions, specifically sadness, after reading the content and he/she gave a high rating. Thus, this piece of content can be considered the user's preferred content, however preferred when in such a negatively valenced aggregated affective state. The next time the user comes to the website and they are experiencing sadness intensely, they would likely want to be recommended similar content to the one they expressed they preferred when in a negatively valenced aggregated affective state. This might sound counter-productive, i.e., potentially enhancing a state which is already negative. However, it is not uncommon that we desire more of that which reflects our emotions. For example, when we are sad, it is more likely that melancholic, sad music would resonate with us [305]. Or when in the state of anger, we have a greater predisposition for action-oriented, anger expressive, movies or music [305]; or when relaxed and joyful, wanting to watch a comedy. This might not be the case

with all emotions and all content types; for example it might not be that when fearful we want more fear evoking music or horror movies. However, for the most part, we synchronise better with events, people and content that correspond to our affective state [306].

This reasoning is even more so applicable to the case of cancer website content. Moreover, it is the rating that is the main indicator of a preference for content. Furthermore, the rating allows discriminating between content items when experiencing the same affective state; for example, in a negatively valenced aggregated affective state a user might give a high rating to one content item, however give a low rating to another. Importantly, the recommendations algorithm proposed here does not try to match the user's emotions with the predominant sentiment of a content (which would be predetermined for each content item). Instead, recommendations are made based on the emotions the content evoked in the user; moreover, only if, in that specific affective state, the user also expressed liking the content.

Continuing with the explanation of the A1 algorithm, only considered is the preferred content for which the user reported emotions (A1: step 11 and 12). This means that if emotion-based recommendation is triggered and applied, there could be items of preferred content for which the user only gave a rating, but did not report emotions, and which would be filtered out at this step. This was a design choice for this research, which could be optimised. It has potential negative implications for users who are accustomed to and reliant on ratings as indicators of the type of content they prefer. Potentially, thus, such users would perceive the emotion-based recommendations not to reflect what they expected or believe that the presented recommendations reflect all their preferences (ratings, emotions, interests); this could thus negatively affect their experience. However, it needs to be explored in future research whether such a negative effect on user experience actually occurs. Moreover, emotion-based recommendations are only triggered if the user decides to report their emotions to the website. Given that users are made aware how emotions reflect on content recommendations (via the Why recommended? feature), those users who rather rely on parameters other than emotions

(e.g., ratings), can choose not to report their emotions, and therefore obtain non-emotion-based recommendations.

Next, the *selected preferred content* is used to generate the content recommendations. In step 12 of A1, the **A1.1 algorithm** (Figure 5.11) is triggered. A1.1 uses content filtering techniques to generate content recommendations for an ‘existing’ user. It applies the *k*NN algorithm [307] which is well-known and widely used in filtering techniques (e.g., Resnick’s algorithm [308]), including emotion-based contextual recommenders [186].

The *k*NN algorithm is applied to every item of *c* (i.e., preferred content) to find the most similar content which the user has not read. The *content type* of the preferred content is identified (A1.1: step 2) to assign the *number of nearest neighbours (k)* (A1.1: step 3). For instance, for *articles* $k = 10$, for *forum discussions* $k = 3$, for *blogs* $k = 5$ and for knowledge base content, k is the index of similarity $> 50\%$. I assigned the k for each content type based on the amount of that content on the PORT website, the frequency with which it was updated on the website, the findings which showed that users preferred to view certain content over other (e.g., articles over forum), and to restrict the number of recommendations presented on the user profile page.

A1.1. Applying kNN algorithm to generate content recommendations

Input: items of preferred content *c*, types of content, *k* for each content type, content the user did not read - filtered by interests

Output: list of content recommendations - articles, blogs, knowledge base articles, forum discussions

```

1. for each c do
2.   determine content_type
3.    $k = \text{AssignK}(\text{content\_type})$ 
4.   nc = FilterByContentType(content_not_read, content_type)
5.   for each nc do
6.     nc_similarity = RMF(c, nc)
7.     content_recommendation = GeneratekNN(nc_similarity, k)
8.   end for
9. end for

```

Figure 5.11. Applying kNN algorithm to generate content recommendations (pseudo code)

The function *FilterByContentType()* takes the *content type* of *c* and filters out the *content_not_read* that is not of the same content type (A1.1: step 4). The result is a list of

new content (nc). The *ratio of mismatched features* (RMF) is then applied to each nc (A1.1: step 6).

RMF (Equation 6) is used as a distance function, to calculate *nc_similarity* - the distance between the selected preferred content c and the new content nc . Depending on the content type, compared are only the *interests* that the content reflects (in the case of blogs, knowledge base, and forum discussions), or interests and *category* of the content (for articles). Here, NI is the *total number of parameters* a content type can be classified by, and NMI is the *number of matching parameters* between c and nc .

$$RMF(c, nc) = dist(selected(preferred(c)), nc) = \frac{NI - NMI}{NI} \quad (6)$$

Finally the *GeneratekNN* function (A1.1: step 7) generates a list of content recommendations, by sorting the obtained RMF results to find the k smallest distances, i.e., the k most similar nc items the user has not read to the c item of the user's preferred content.

Finally, A1 algorithm uses the *FilterRecommendations()* function (A1: step 14) to filter out repeated recommendations, if an instance of content is recommended more than once.

5.3.1.1.1 Similarity vs. complementarity measures

Recommender systems generally search for similar objects to recommend [76, 186], and those that have nothing in common (i.e., complementary objects) to avoid recommending [309]. In generating content recommendations on the PORT website, similarity measures were the basis for finding the k most similar content items or k most similar users. Nevertheless, research on recommender systems also presents certain approaches for incorporating measures of complementarity.

Khalaji and Mirabedin [310] proposed measuring both the degree of similarity and complementarity between products in recommender systems for electronic markets. Complementarity can be used in maximizing the variety of items that are recommended [311]. In online retail, the utility of a recommendation of pants increases if a

recommendation for a matching shirt is made in the same list [311]. Also, in online grocery shopping, a recommendation list is more useful if it contains olive oil and a variety of other items (e.g., feta cheese), that might not be of the same type, but are frequently bought together [311].

Other approaches to employing complementarity are also possible. Xi et al. [312] used complementary matrices to integrate different relationships from various sources (e.g., content on the Web), and hence generate better quality information. Nevertheless, as in this research, their aim was to measure similarity between data objects (e.g., documents or search query results), even when these objects are very diverse and represented by different types of relationships.

Complementary data was also considered in social recommender systems [313]. Specifically, Kim and Srivastava [313] addressed the question of recommending a product which does not match the consumer's preferences (i.e., might be complementary to preferred products), but which was rated highly by other consumers in the same social circle (i.e., similar, matching consumers). Moreover, in forming effective teams in enterprises, team members' recommendations are superior when they taken into account not just the similarities but also the differences between people (e.g., in personality traits) [314].

As in other fields, the use of complementarity measures should be considered in future research on recommender systems for cancer websites. For example, recommendations should comprise heterogeneous content types; i.e., generating a content recommendation could be based on items of the same content type, but also those of a complementary content type, which a user viewed and liked most commonly together. Moreover, in optimising collaborative filtering, content preferred by the k most complementary users could be removed from the list of recommendations generated for the current user. Nevertheless, this discussion in no way neglects the importance of similarity measures, as they are the essence of the recommendation process.

5.3.1.2 A2: Algorithm for generating emotion-based content recommendations for new users

The case of a ‘cold start’, when a user has not read and rated content (‘new user’, *nu*), is addressed by the **A2 algorithm** (Figure 5.12, step 2). Collaborative filtering is applied. The rule for A2 states that the *most similar existing user is the one with the most similar user demographics and interests, but also the one who, during their latest visit to the website, was in an aggregated affective state that reflects the current aggregated affective state of the new user*. Note that the algorithm looks only at users who have already read and rated website content (named here ‘existing’ user) to find the user who is the most similar to the new user, and thereby to recommend the most similar user’s preferred content.

RMF is used to calculate the distances between users (A2: step 4), for which a simplified formula is presented in Equation 7, where *NC* is the *total number of characteristics* a user is profiled by, and *NMC* is the *number of matching characteristics* between new user *nu* and existing user *u*.

$$RMF(u, nu) = dist(u, nu) = \frac{NC - NMC}{NC} \quad (7)$$

A2. Emotion-based content recommendations algorithm: New user

Input: user login data, new user’s emotions at login, existing user’s emotions at login, all user ratings, all user demographic information and interests (75 interests, county, gender, age ranges, whether user wants their name as public (Yes/No)) collected through the registration process and profile editing.

Output: recommended content - articles, blogs, knowledge base articles, forum discussions - for new user

```

1. for each login do
2.   if (average_rating = 0) then
3.     for each existing_user do
4.       nu_similarity = RMF(existing_user, new_user)
5.       most_similar_user = GeneratekNN(nu_similarity, 1);
6.       newu_aggregated_affective_state = AggregatedAffectiveStateAtLogin(emotion_intensity)
7.       existu_aggregated_affective_state = LatestAggregatedAffectiveStateAtLogin();
8.       if newu_aggregated_affective_state = NULL then go to step 13
9.     else
10.      if newu_aggregated_affective_state == existu_aggregated_affective_state
11.        go to step 13
12.      else, exclude most_similar_user and go back to step 5 to find the next most similar user;
13.    recommend content
14.   end for
15. end for

```

Figure 5.12. Emotion-based recommendation process for new users (pseudo code)

The characteristics a user is profiled by on the PORT website are demographic data and interests. Demographic data - gender, age, whether a user wants their name to be public, and canton (county or region) the user is from - are checked if they match for the two users. Interests (explained in Section 5.2.2) are considered differently. Given that there are 75 different interests and only four demographic parameters, the distance function would be significantly biased toward interest data. The weight of interests' data is reduced by comparing users at the *interest category level*. Hence, two users *match* (1) at an interest category level if they selected *all the same interests within that category*, otherwise they do not match (0) for that interest category; the approach applied to this research to ensure the greatest interest-based similarity. All *four interest categories* are used in RMF calculations, along with the *four demographic characteristics*, making up the total of 8 characteristics a user is profiled by, i.e., *NC*. *NMC* is increased by 1 for every match in characteristics.

The *GeneratekNN* function (step 5) finds the most similar ($k = 1$) 'existing' user. The algorithm checks if both new user and the most similar user reported their emotions. The previously explained function *AggregatedAffectiveStateAtLogin()* calculated the valence of the new user's aggregated affective state (A2: step 6) and records it as positive, neutral or negative (Section 5.3.1.1, Equation 4 and 5), or not reported (NULL). On the other hand, the function *LatestAggregatedAffectiveState()* computes and retrieves the most similar 'existing' user's aggregated affective state – this is the login aggregated affective state the existing user reported at their latest visit to the website (A2: step 7).

A potentially better solution would have been to calculate the most similar user's average aggregated affective state (or the most frequently reported one). That might have better indicated the type of content preferred by a user who visits the website predominantly in the new user's matching aggregated affective state. However, it would have been computationally very demanding, because the most frequent aggregated affective state would have to be recalculated at every session, from every report of emotions the most similar user has made so far. Therefore, the current simpler approach was taken. It was viable for this research, given that currently the majority of the PORT website users are first-time visitors and have used the website only once. Thereby, the current users' last

reported aggregated affective state very closely reflects their most frequent aggregated affective state. Nevertheless, other approaches for determining the aggregated affective state of the most similar user should be looked into in future research.

Depending on whether the new user reported their emotions, *three scenarios* are possible. If the new user *did not report their emotions* (A2: step 8), the *similarity* between users *u* and *nu* is computed only *based on their demographic data and interests*, as is the general approach in collaborative filtering [315, 316] and ‘traditional’ user profiles [33]. In that case, the content preferred by the most similar user is processed in the A2.1 algorithm (Figure 5.13).

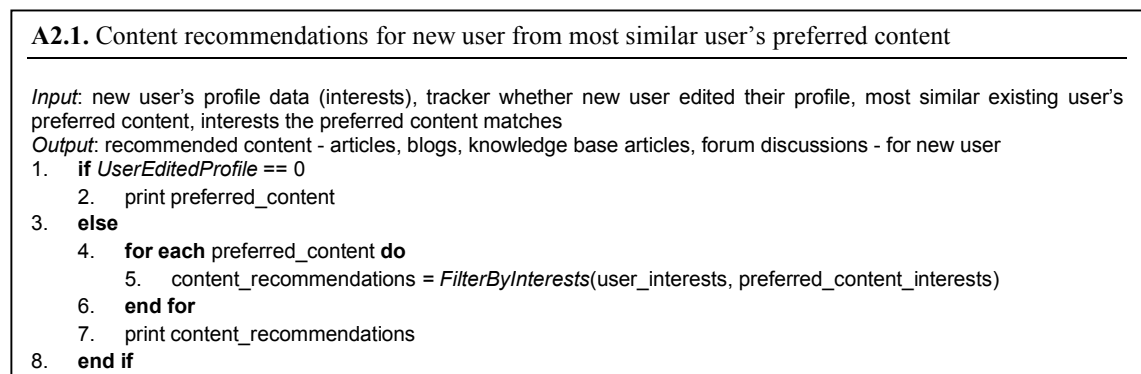


Figure 5.13. Generating content recommendations for new user from the most similar user’s preferred content (pseudo code)

However, if the new user *reported their emotions*, two scenarios occur. If the *aggregated affective state* of *u* and *nu* *match* (A2: step 10), the algorithm A2.1 is triggered to generate content recommendations. Otherwise, the current most similar user is discarded for that website session (i.e., that instance of generating the feed of recommendations) (A2: step 12), and the *next most similar existing user* is found.

The **A2.1 algorithm** *generates the actual content recommendations for the new user from the preferred content of the most similar ‘existing’ user*. The function *UserEditedProfile()* (A2.1: step 1) tracks if the new user visited the Edit Profile page and identified their interests. If the new user *did not edit their interests*, *all the preferred content* of the most similar user *is recommended* (A2.1: step 2). However, if the new user *edited their interests*, the *FilterByInterests()* function is triggered. The function works in

the same way as the corresponding function in A1 (A1: step 6). Thereby, *user interests* are *matched against the interests that the preferred content addresses*. Only those items of the preferred content that satisfy at least one of the new user's interests *at each interest category level* are recommended (A2.1: step 5).

5.3.1.3 Optimisation

Some level of **optimisation** of the algorithms was performed at this stage of the research. For example, *revising how interests at the user and content item level* are used. Initially each interest option (75 of them) was matched at the individual interest-option level between two users (in finding nearest neighbours) or between two content items. The current algorithms perform *comparisons at the interest category level*. Secondly, an *additional level of filtering* was included, whereby the new content, content a user has not yet read, has to first match user's interests at each interest category level, prior to being considered for recommendation.

Thirdly, given that the algorithm uses *average rating* as a benchmark for determining a user's preferred content items, adjustments were made to ensure that a user who has rated a certain amount of content would be offered recommendations. Thereby, *preferred content items* are those that have a *rating higher than or equal to the average rating*, instead of only above the average rating. With this provision, users who have, for example, rated all the content they have viewed so far with 5 stars, even with an average rating of 5, can however be recommended content.

Nevertheless, optimisation of the recommendation algorithms and exploring the latest trends in recommenders was outside the scope of this research. Certain main areas for improvement have been outlined in Chapter 9 (Section 9.3); however, these are questions to be explored in future research, specifically focusing on recommender systems.

5.3.2 *Emotion-based adaptation: Algorithm for cancer website emotion-based adaptation*

The approach of *mapping rules* was adopted from Germanakos et al. [33]. They have used emotional parameters (e.g., anxiety level) as implications of the type of adaptation that would be applied to an e-learning environment. In their model, emotional processing parameters (i.e., high, medium, low) affected additional navigation support and aesthetics of a web page. Whereby, for example, high anxiety level implied triggering the adaptation rules that increased the size and weight of the font of the e-learning content.

The rules for **algorithm A3** (Figure 5.14) were extracted from the significant correlations found in Study 2-Study 4 (see Appendix M) and Study 4 classification rules (see Chapter 7, Section 7.6.5.1). The combination of these findings suggests that *certain emotions experienced at the start or during website use predict a preference or dislike for specific website features*. For example, *shame* was shown to be negatively correlated with the feature *filtering recommended content on user profile page*. The correlation is addressed in A3 with the following type of a rule:

IF *shame* is felt at login, THEN the user will be *directed away* from the *filter on the profile page*, by hiding it or making it less visible to the user.

ELSE, IF *shame* is *not felt*, THEN the *feature* is *highlighted*, to direct the user to it.

The functions *HighlightFeature()* and *HideFeature()* apply the two types of adaptation, and are explained later in this section. The A3 algorithm utilises the *emotions reported* both *at login* and *during the website visit*. Emotions reported at different stages of website use (starting, dominant and end emotion) have been explored in emotion-based contextual recommenders [186]. In this respect, *the A3 algorithm is the most advanced of the three emotion-based algorithms, as it considers login and during use emotions, and individual and combinations of emotions*.

Thereby, this algorithm represents the ultimate achievement of this research, incorporating *emotions reported at any stage of the website use to trigger adaptation*. Unlike the content recommendations algorithms (i.e., A1 and A2), in A3 if the user

chooses not to report their emotions (i.e., ignores or closes the *Emotion Tool*), *no adaptation* occurs and the default appearance of the website is presented (A3: step 3). Nevertheless, even if no emotions are reported, forms of website adaptation occur during website use, depending on user activities. For example, adaptability resulting from user customisation of text font, or adaptivity triggering the automatic change of website background colour after the user defined their favourite colour. On the other hand, if the user *does report their emotions*, the adaptation that is triggered is either **hiding** or **highlighting** features (explained in the next section).

A3 is triggered by user login. At login (A3: step 2) the algorithm tracks the number of reported emotions (step 3). *If no emotions are reported*, a *default website* is presented (step 3), and the system moves on to tracking every use of the *Emotion Tool* during that website session. Otherwise, *if login emotions are reported*, the algorithm checks each *discrete emotion* and its intensity (A3: step 5), as well as the *combinations of reported emotions* (A3: step 11), to determine whether and *which adaptation to apply* (A3: step 7 and step 13). A list of the detailed adaptation rules showing the conditions that have to be met for the discrete emotions (or combinations of emotions) and the type of adaptation they trigger, is provided in Appendix F. This set of predefined adaptation rules is recorded in the system, and is based on the findings (correlations and classifications) of this research (see Chapter 7). Examples of the rules are presented later in this section.

The algorithm checks for *each discrete emotion reported at login* (A3: step 5) whether a predefined adaptation rule exists for it (A3: step 6). If the function *AdaptationApplicable()* returns a positive value, it indicates that the specific login emotion predicts a (dis)like of one or more of personalisation features. Depending on the intensity of that emotion, the *ApplyAdaptation()* function applies the *highlighting or hiding type of adaptation to all the personalisation features which that emotion affects*.

A3. Algorithm for emotion-based adaptation

Input: user log in data, login emotions and intensities, emotions and intensities reported during website use.

Output: changes to website layout and features' appearance

```
1. For each log in do
2.   For each login_EmotionTool_use do
3.     If reported_emotions == 0, present default website and go to step 19
4.     Else If reported_emotions ≥ 1
5.       For each login_emotion do
6.         If AdaptationApplicable(login_emotion) == Yes;
7.           ApplyAdaptation(login_emotion, emotion_intensity, personalisation_feature);
8.         end if
9.       end for
10.    If reported_emotions ≥ 2
11.      For each CombinationOfLoginEmotions do
12.        If CombinationReported(emotions, intensities) == Yes;
13.          ApplyAdaptation(login_emotion, emotion_intensity, personalisation_feature);
14.        end if
15.      end for
16.    end if
17.  end if
18. end for
19. For each DuringUse_EmotionTool_use do
20.   If reported_emotions == 0, go to step 35
21.   Else If reported_emotions ≥ 1
22.     For each du_emotion do
23.       If AdaptationApplicable(du_emotion) == Yes;
24.         ApplyAdaptation(du_emotion, emotion_intensity, personalisation_feature);
25.       end if
26.     end for
27.   If reported_emotions ≥ 2
28.     For each CombinationOfEmotions do
29.       If CombinationReported(emotions, intensities) == Yes;
30.         ApplyAdaptation(du_emotion, du_intensity, login_emotion, emotion_intensity,
          personalisation_feature);
31.       end if
32.     end for
33.   end if
34. end if
35. end for
36. end for
```

Figure 5.14. Adapting website features to user emotions (pseudo code)

The algorithm also checks if more than one emotion was reported at login (A3: step 10). The *CombinationOfLoginEmotions()* function (step 11) goes through the adaptation rules that address the conditions which satisfy more than one discrete emotion (six such adaptation rules are recorded in the system – see Appendix F). The function *CombinationReported()* checks if all the emotions in the predefined rules have been reported by the user, and whether the reported emotions' intensities satisfy the adaptation rule's conditions (A3: step 12). If the condition is met, the *ApplyAdaptation()* function

(A3: step 13), triggers the adaptation of those website *features* which were found to be affected when feeling that specific combination of *emotions*. For example one of the rules listed in Appendix F is:

IF at login ***sadness*** is moderate (3) or greater AND ***surprise*** is moderate or less,
THEN ***highlighting*** adaptation is applied to the *articles*' related content.

As explained at the beginning of this section, *emotions reported during website use* also trigger adaptation (A3: step 19), *every time the Emotion Tool is used*. The same process occurs as at login, whereby both individual discrete emotions (A3: step 22) and combinations of discrete emotions (A3: step 28) are matched to predefined adaptation rules. The difference is that the rules for *combinations of emotions* (A3: step 27 - 30) can *comprise* both *login* and *during use emotions* (as illustrated by the two rules below). If the during-use emotion (or a combination of during-use and login emotions) triggers adaptation, the *ApplyAdaptation()* functions (A3: step 24 and 30) adapt the website features affected by those emotions. There are *six adaptation rules for the during-use emotions* (see Appendix F), of which two are conditions with two or more emotions, and these are:

IF at login ***surprise*** ≤ 2 AND *during use* ***joy*** > 1 , THEN adapt the feature *adaptive storyline* by ***highlighting*** the background in green.

IF at login ***surprise*** > 1 AND *during use* ***surprise*** ≥ 3 , THEN adapt *Forum discussion recommendations* by ***highlighting*** them.

Types of adaptation: The feature adaptation approach used on the PORT website is self-devised, based on adaptive hypermedia literature, including Brusilovsky's well-known taxonomy [79], and on the existing systems which incorporate adaptive hypermedia, e.g. GRAPPLE [88]. As previously explained, *two types of adaptation* are applied to the PORT website features:

- ***Hiding*** features – users are guided *away* from features; features are hidden by not presenting them at all on the website (e.g., the F1 feature in Appendix G) or showing them in a less visible format (e.g., F3 in Appendix G).

- **Highlighting** features – users are guided *to* features; highlighted features are made more visible, their presentation stands out by using different or brighter colours than the ones commonly used on the website.

In *hiding adaptation*, whether feature removing or hiding is applied, depends on the respective features, i.e. the way removing information would affect the surrounding material, as well as based on the ease with which the information can be 'hidden in plain sight' (see Appendix G for the types of hiding adaptation). On the other hand, *highlighting adaptation* was *exclusively* implemented by *applying green colour* as the *background* or the *font colour*. This is based on the traffic light metaphor, whereby *green* symbolises “go”, i.e. directing the user to action. Green, moreover, complements other colours of the website (white and purple), but also stands out compared to them. In feature highlighting, alternatively red and yellow could have been used, however both had drawbacks. Red was avoided, since it mainly implies a ‘stop’ action, or a warning. Orange and yellow were also avoided, since yellow is the main colour of the Emotion Tool, and both are less visible, depending on how the website is displayed. Note that Study 5 interviews confirmed this reasoning; users *complimented the use of green colour in highlighting*, and moreover claimed that *red would not have been the desired choice*, as it would not stimulate them to action, but rather cause confusion (Appendix L).

Based on the findings of this research (Appendix H and Appendix M), 25 different features and content types on the PORT website can be adapted to user emotions; the remaining features are not affected by adaptation. Appendix G presents the adaptation applied to the individual features. For example, **highlighting** is applied to the feature *User profile customisation* (F1), whereby the notifications to go to the user profile and edit it are changed into brighter colours and the background for the Edit profile link is coloured in green. Another example of feature highlighting is displaying green borders around the *Knowledge base recommendations (on KB pages)* to guide users to this content.

The features are also adapted *to guide* the user *away* from them, if the emotions experienced by the user recommend that. The type of adaptation referred to here is called feature **hiding**. Hiding on the PORT website is applied to fewer features. For example,

the *hiding* applied to the feature *user profile customisation* results in all the notifications that remind the user to go to the profile and edit it to be turned off. Thus, the *orange triangle* in the upper right hand corner of the website and the *red rectangle* on the user profile page are *removed*. The user could still edit the profile, by reaching it via menus, but it would have to be a purposeful action on their behalf.

The second type of hiding adaptation is that applied to, for example, *filtering recommended content on the user's profile*. In this case, only *a link* to the filter (the word *Filter*) is presented; if clicked, the full filter is opened, visible as in the version without hiding. The third type of hiding is applied to recommendations, for example, *article recommendations (on Articles pages)*, whereby the background of the recommendations on top of Articles related pages is coloured in grey to blend with the grey website background, instead of the default purple colour.

Next, the implementation of the personalisation algorithms on the PORT website is demonstrated.

5.4 Illustration of emotion-based personalisation on the PORT website

In the remaining part of this chapter, the effect of the A1, A2 and A3 algorithms on the PORT website is shown. For these purposes, several test user profiles were created, some as 'existing' users, and others as new users.

5.4.1 Implementation of A1

Two scenarios were run to demonstrate the A1 algorithm (Section 5.3.1.1); the first, when the user is in a *positively valenced aggregated affective state (PAAS)*, and the second when in a *negatively valenced one (NAAS)*. To instantiate the user into 'existing' users, the user rated some content on the website, and to ensure that emotion-based personalisation can be applied, at each rating emotions were reported.

The simulated user first rated with high rating several *articles*, to classify them into the preferred content, and reported *PAAS* at each content rating. Next, the user also highly rated some of the *forum* content, reporting, however, *NAAS* in this case.

Scenario 1: At the next login, the user reported mainly intense positive emotions. Given that the user's preferred content was filtered to match the PAAS, what remained is the content for which a PAAS was assigned at rating, which in this case were *articles* (Figure 5.15). The generated recommendations are *articles* the user has not yet read, and that reflect user interests.

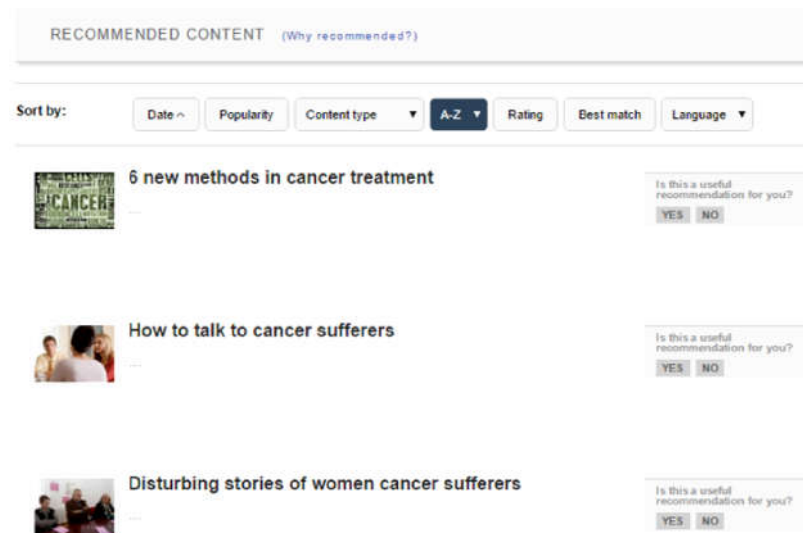


Figure 5.15. Recommendations for positively valenced aggregated affective state

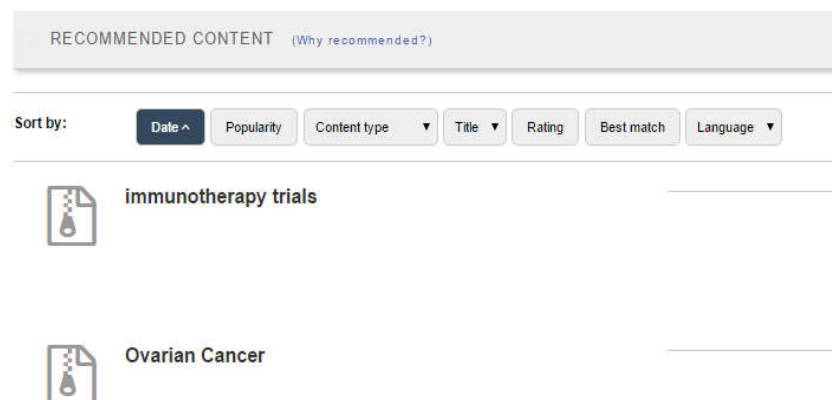


Figure 5.16. Recommendations for negatively valenced aggregated affective state

Scenarios 2: The user reported predominantly intense negative emotions. Thereby, user's preferred content is filtered, keeping only content related to the user's *NAAS*. These are the here rated forum discussions for the user in question. Hence, the algorithm generates recommendations of other unread forum content, which also reflects user's interests (Figure 5.16).

5.4.2 Implementation of A2

A2 (Section 5.3.1.2) is also simulated with two scenarios: using the profile of one new user, but logging in two times, each time reporting different emotions. The profile data of the new user was edited, so that the new user's cancer-related interests are identical to those of the previously presented 'existing' user to show that the existing user's preferred content would be recommended.

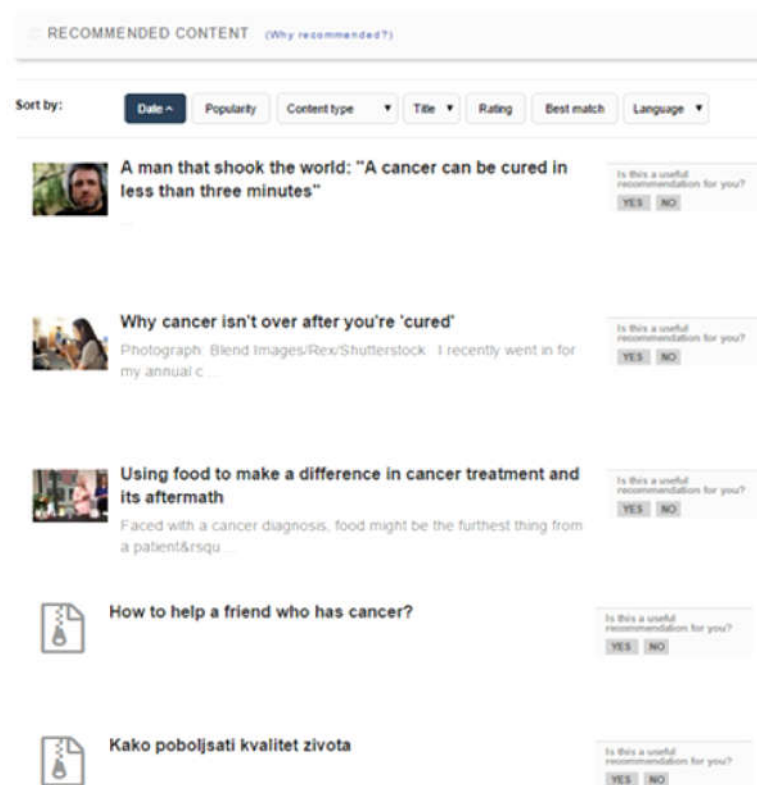


Figure 5.17. Recommendations when a new user is in a negatively valenced aggregated affective state

Scenario 1 presents the case where the new user reports a *NAAS*. The website searches for the most similar existing user, until it finds the one whose latest aggregated affective state was also negatively valenced, and recommends to the new user their preferred content. In this simulation, the most similar user was the previously presented existing user, with the matching *NAAS*, who preferred a few articles and forum discussions. As seen in Figure 5.17, these were recommended to the new user.

In *Scenario 2*, the new user *did not report* emotions; hence searching for the most similar existing website user was not based on user emotions, but only based on their interests and demographic data (explained in Section 5.3.1.2). The most similar user in this case is not the same as in the first scenario, as can be seen by the recommendations provided to the new user (Figure 5.18).

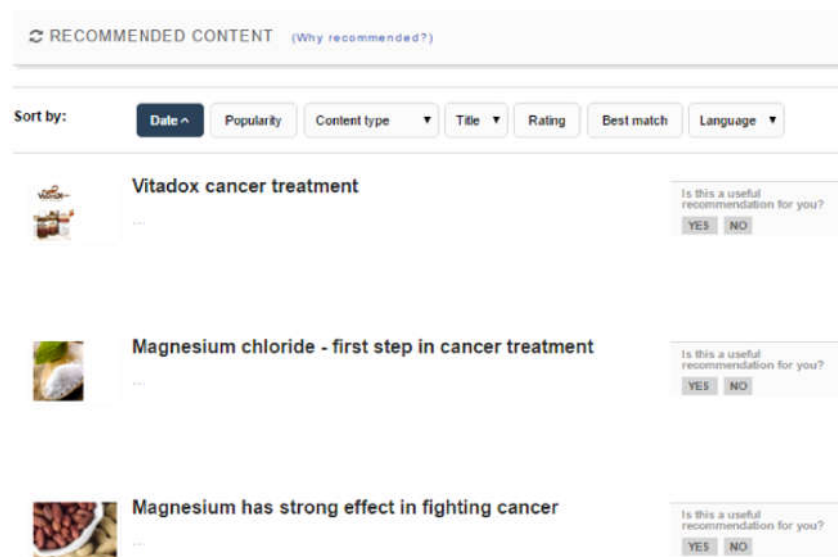


Figure 5.18. Recommendations when a new user does not report emotions

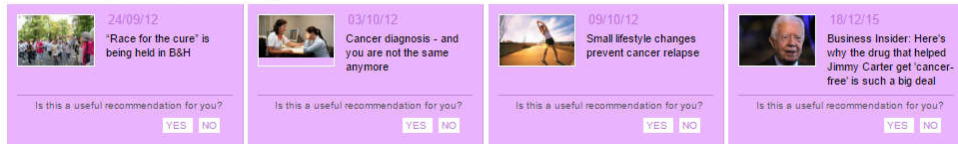
5.4.3 Implementation of A3

The A3 adaptation algorithm (Section 5.3.2) is simulated for several of the most representative cases of the adaptation rules (Appendix F): for a single discrete emotion, e.g., *surprise* and *interest during use* and *disgust at login*, and for a combination of discrete emotions, e.g., *shame, joy* and *surprise at login*.

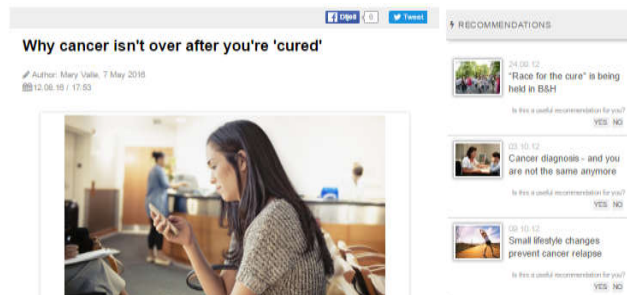
A. Default

On Articles' main page

We recommend, based on your interests, preferred content and emotional state:



Within article content



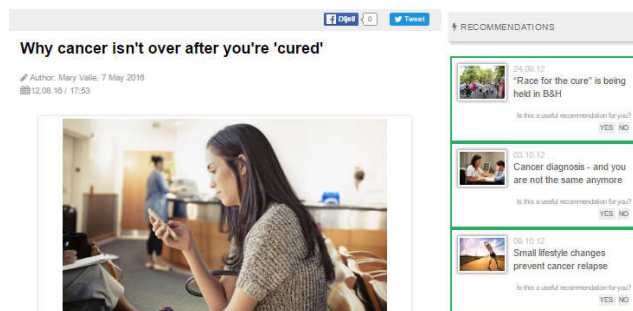
B. Highlighted

On Articles' main page

We recommend, based on your interests, preferred content and emotional state:



Within article content



C. Hidden (*Within article content (as in the default state; no adaptation is applied)*)

On Articles' main page

We recommend, based on your interests, preferred content and emotional state:

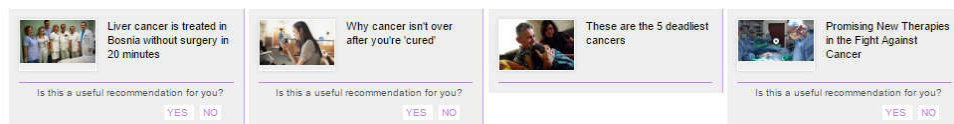


Figure 5.19. Adaptation for Articles' recommendations

A. Default state

On Articles' main page

In the main menu and Knowledge base pages

B. Highlighted

On Articles' main page

In main menu and Knowledge base pages

Figure 5.20. Adaptation for Articles

Adaptation for **surprise** is depicted in Figures 5.19 and 5.20. The adaptation rule for this emotion states that if *surprise* is felt (intensity 1-4) *during website use*, it predicts a *preference* for *article recommendations*. Also, if surprise is reported, with any intensity (i.e., 0-4), there is a *preference* to *view articles*. *Articles' recommendations* (F15) are displayed on the PORT website on top of the Articles' main page, and on the right side of an article content page (Figure 5.19 - A). If *surprise* is reported with a *mild* or *higher intensity* (intensity 1-4), the individual *recommendations* are **highlighted** with a *green border* surrounding them, and the explanation text '*We recommend, based on your interest, preferred content and emotions:*' is coloured in *green* (Figure 5.19 - B). Changes in the intensity of surprise *do not trigger the hiding* of this feature, as per algorithm, based on the Study 4 findings in Chapter 7 (Section 7.6.5.1). The *hiding* adaptation for this feature occurs when, for example, *interest* is *not felt at all* at login, in which case the background of the individual *article recommendations* is changed to *grey* (Figure 5.19 - C).

The intensity of *surprise* also predicts *Articles* (F18) will be preferred or disliked, as depicted in Figure 5.20. Articles on the PORT website are displayed within the Articles tab, on user profile and on Knowledge base pages. By default the *title* of an *article* is in black and bold font (Figure 5.20 - A). If **surprise** is *reported during website use*, irrespective of the intensity (any intensity 0-4), articles are recommended by **highlighting the titles in green** and colouring the *Articles tab* in the main menu in *green* (Figure 5.20 - B). **Hiding** or removing articles is not implemented on the website as the findings did not indicate users dislike the feature when feeling any of the emotions.

Adaptation that results from reporting the emotion **disgust** at *login* is illustrated in Figures 5.21 and 5.22. **Disgust** predicts the feature *Commenting* (F3) (Figure 5.21 - A). Similar to the previous feature, when *disgust* is *not felt*, the *textbox for comments* within all contents that allow commenting (articles and blogs) and *previously posted comments* are highlighted in *green* (Figure 5.21 - B). If *disgust* is *felt* the *comments* are *hidden* and *textbox* for commenting is *replaced with a link Comment*, which opens the *textbox* for commenting, if clicked on (Figure 5.21 - C).

Disgust also predicts the feature *user profile customisation* (F1) (Figure 5.22 - A), based on the correlation findings in Chapter 7 (Section 7.6.4). When disgust is *not felt*, the *Edit profile* link within MyPORT menu is **highlighted** with a green background (Figure 5.22 - B). When it is *felt* (intensity 1-4), the *notifications* to go to user profile and edit it are *turned off*. For example the *orange triangle* that appears in the upper right hand corner of the website and the *red rectangle* in user profile – both indicating that user profile data is missing and should be completed – are **hidden** (Figure 5.22 - C).

Experiencing **disgust** at login with a *mild or higher intensity* (1-4) triggers the highlighting adaptation of the feature *KB recommendations* (F14). Highlighting and hiding of KB recommendations is the same as that applied to the Article recommendations presented in Figure 5.19.

When **interest** is reported *during website use*, it predicts user preference or dislike for using *search tools* (F20). PORT website's search tools are depicted in their default state in Figure 5.23 – A. If a user reports *interest* in the intensity - *not at all* to *moderate* – the website **highlights** in green: the *search box* on Home page, the background of the *search tool* in the upper right corner of the website, and the *search boxes* in Forum and Blogs (Figure 5.23 - B). The *HideFeatures()* adaptation is also not applied in this case.

In some instances, feature adaptation is triggered only when conditions for several emotions are satisfied at the same time. For example, users are **guided** to *content recommendations* (F21) presented within the *user profile* page (Figure 5.24 - A) if they expressed at login that they *do not feel shame at all*, they *do not feel surprise*, and they *do not feel joy*, or *feel joy* with an *intensity* of 3. When such a condition is met, it triggers the adaptation to **highlight** the background of *profile recommendations* (Figure 5.24 - B). No adaptation for this feature occurs if the condition is not met.

Various other types of adaptation to website features occur as a result of the emotions reported. These were just the most prominent examples. The rules for other emotions and the features they affect can be seen in Appendix F.

A. Default state



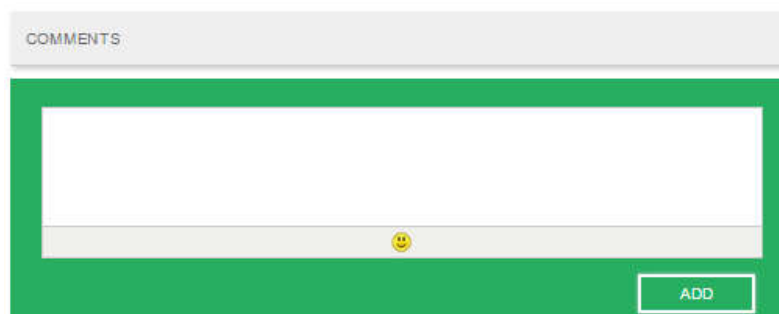
COMMENTS

😊

ADD

The default state shows a form with a header 'COMMENTS', a large text input area, a row with a smiley face emoji, and a green 'ADD' button.

B. Highlighted



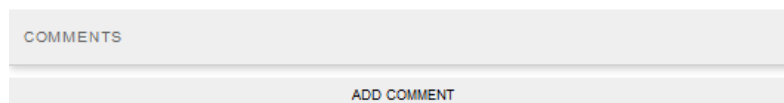
COMMENTS

😊

ADD

The highlighted state shows the entire form area enclosed in a thick green border. The 'ADD' button is now white with a green border.

C. Hidden



COMMENTS

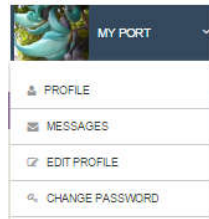
ADD COMMENT

The hidden state shows only the header 'COMMENTS' and a single row with the text 'ADD COMMENT'.

Figure 5.21. Adaptation for Comments

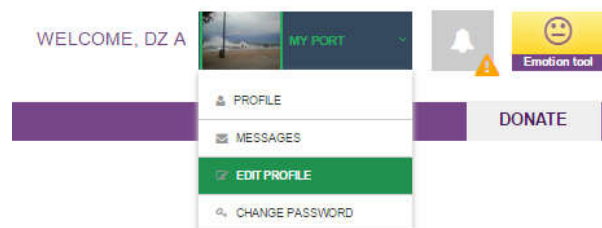
A. Default state

Edit profile in My PORT menu



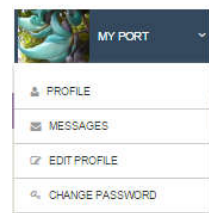
B. Highlighted

Edit profile in My PORT menu



C. Hidden

Edit profile in My PORT menu (as in default state)



Red rectangle and orange triangle are removed (as shown in the area marked in red)

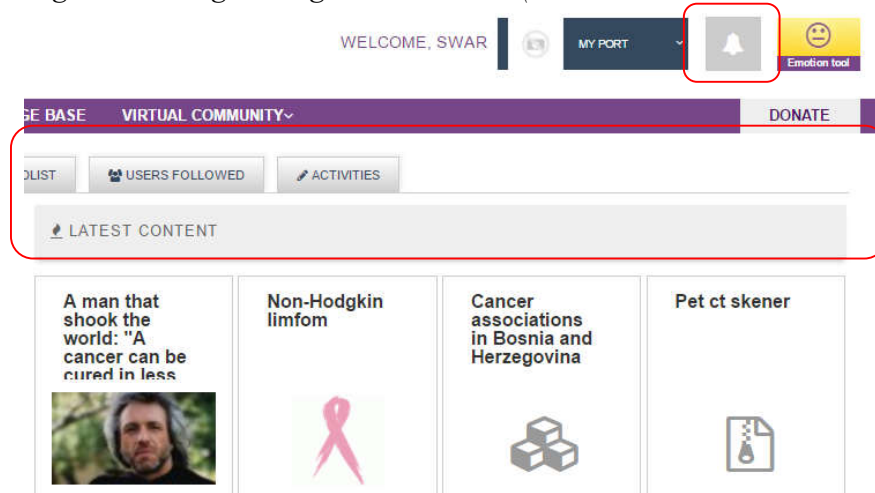
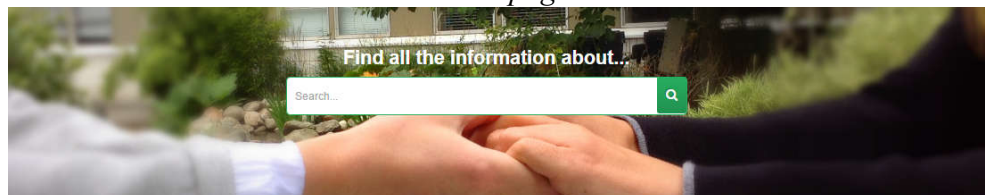


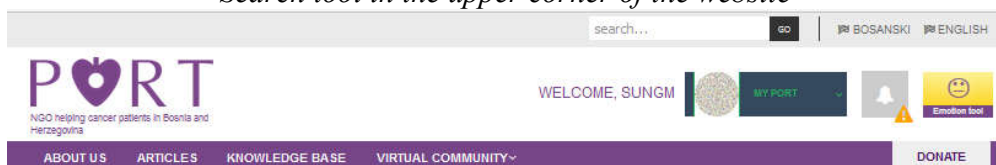
Figure 5.22. Adaptation of features directing users to customise their profile

A. Default state

Home page



Search tool in the upper corner of the website



Forum search

[HOME / FORUM](#)

Search... >

Blog search

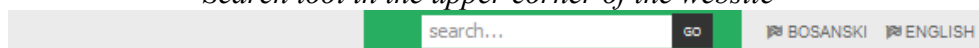
Find a blog... OK

B. Highlighted

Home page



Search tool in the upper corner of the website



Forum search

[HOME / FORUM](#)


Search... >

Blog search

Find a blog... OK

Figure 5.23. Adaptation for Search

A. Default state

 RECOMMENDED CONTENT [\(Why recommended?\)](#)

Sort by:

Date ^

Popularity


Content type ▼

Title ▼

Rating

Best match


Language ▼



Vitadox cancer treatment
...

Is this a useful recommendation for you?


YES NO



Magnesium chloride - first step in cancer treatment
...

Is this a useful recommendation for you?

YES NO



Magnesium has strong effect in fighting cancer
...

Is this a useful recommendation for you?

YES NO

B. Highlighted

RECOMMENDED CONTENT [\(Why recommended?\)](#)

Sort by:

Date ^

Popularity


Content type ▼

Title ▼

Rating

Best match


Language ▼



Vitadox cancer treatment
...

Is this a useful recommendation for you?


YES NO



Magnesium chloride - first step in cancer treatment
...

Is this a useful recommendation for you?

YES NO



6 new methods in cancer treatment
...

Is this a useful recommendation for you?

YES NO

Figure 5.24. Adaptation for Profile recommendations

5.5 PORT website: Current use and future development plans

The PORT website is currently accessible online via the <http://www.port.org.ba/> domain. Website statistics show there are on average 100 visits per week. Approximately 50% of website visitors are from B&H, followed by Croatia and Serbia (countries with similar languages to Bosnian). Visitors who viewed the content in English are mainly from the US, UK, Netherlands, Germany, Austria and the Republic of Ireland.

The website has more than 300 registered users; however, these were participants recruited for the evaluation studies carried out in this research. Website usage data shows that current visitors are only using the non-personalised PORT services, as they are either unaware of the option or unwilling to register and log into the website. In the last 6 months, since the website has been released for real-life use, four visitors have registered to PORT and used its personalised services to a limited extent. This indicates that a website version based on cookies, or other less intrusive methods of user tracking than login, may be the solution for increased use of personalised services on cancer websites.

The plan for the next stage of website development is introducing functionalities which will incentivise website visitors to use emotion-based personalisation, as well as familiarise users with the features they might not have yet encountered on the commonly used online services. Study 5 interviews (Appendix J), with cancer patients who were long-term users of the PORT website, indicate that features which inform why emotions are collected on the website increase and ease user acceptance of emotion-based features. Such services also increase the preference for emotion-based personalisation over other personalisation types. Thus, the following set of assistive functionalities is planned for implementation on the PORT website:

- *interactive user guides* supporting user navigation to: registration forms (personalisation is only available to registered, logged in users), user profile editing (to collect background information and interests required for personalising content and features), and Emotion Tool (to collect emotions for emotion-based personalisation);

- *informative messages* next to each emotion-based feature:
 - explanations about the features' functionality;
 - explanations for the outcomes of emotion-based personalisation – i.e., how user emotions affected feature adaptation or how they reflected on content recommendations (e.g., the currently available feature 'Why recommended?').

The findings of this research (presented in Chapter 6 and 7) have highlighted the potential for adopting emotion-based personalisation on cancer websites - emotion-based personalisation was shown to increase system usability, it was preferred over other types (i.e., levels) of personalisation, and emotion-based features were perceived highly useful. These positive results, supported by additional longitudinal data on how familiarised/trained users interact with emotion-based features, could incentivise wider adoption of emotion-based personalisation on cancer websites.

5.6 Summary

This chapter introduced the PORT website. It described the phases of website design and implementation. It illustrated the website features relevant to this research. It particularly explained the emotion-based personalisation that occurs on the website, through the implemented rules for emotion-based content recommendations and emotion-based feature adaptation.

After reviewing the research methodology and presenting the PORT website in this chapter and the previous one, the findings of this research are presented in the next two chapters. Chapter 6 connects to the current chapter in responding to the first research question. Thereby, sampled users engaged in experiments with various versions of the PORT website to establish users preference for a website without personalisation (default PORT website, when a user is not logged in), generic personalisation (Phase I and Phase II PORT website), or emotion-based personalisation (Phase III and Phase IV website versions).

Chapter 6

Results for RQ 1: User preferences for personalisation

Chapter 6 presents data analysis and findings for the **first research question** on *whether people affected by cancer prefer cancer websites with emotion-based personalisation, generic personalisation, or no personalisation* (RObj5 and RObj8). This research question was addressed in all the five studies. Study 1 looked into the state of the art of personalisation adoption on health websites (RObj2 - RQ 1.2, and RQ 1.1). The remaining four studies evaluated user preferences for a specific level of personalisation - RQ 1.3 and RQ 1.4. The individual results of the five studies are shown in Appendix H.

6.1 Description of research and analysis methods

As explained in Chapter 3 and 4, this research was carried out in *five studies*, in order to follow the development of the personalised PORT cancer website. Thereby, each study served as an evaluation of the level of personalisation implemented up to that point, which was the main aim of RQ 1. A brief reminder of the aims of each of the studies in relation to RQ 1 follows.

Study 1 empirically researched the *state of the art of web-based health services* (RQ 1.1 and RQ 1.2 in Table 3.2). **Study 2** was the first evaluation of the *PORT's personalised website*, and answered: RQ 1.3. **Study 3** further evaluated users' preferences for generic personalisation (RQ 1.3), employing a different experiment design. **Study 4** was the first to *comprehensively answer RQ 1*, by evaluating user preferences for generic personalisation, as well as *for emotion-based personalisation* (RQ 1.4). **Study 5** was a *follow-up*. It primarily looked into re-evaluating *user preferences for emotion-based personalisation* on a cancer website (RQ 1.4) by changing the experiment design (see Chapter 4, Section 4.4.4).

Quantitative data was primarily collected in answering RQ 1. The following **analysis methods** were applied: *descriptive statistics* were used to summarise participant

demographic data, *Cronbach's Alpha* confirmed research factors' reliability, and *inferential statistics* were carried out to test the research hypotheses. The analysis was mainly carried out in the well-known IBM SPSS v20 tool [317], while Microsoft Excel was used for graphical representations. ***Qualitative data*** – e.g., participants' comments collected via surveys and interview responses – were manually analysed or with the QSR NVivo 10 tool [318]. ***Triangulation*** was employed throughout the research (surveying, interviews, website logs, longitudinal data) to address the hypothesised relations.

The results, organised around the research questions, are next presented. Each section states the findings reached by the individual studies, identifies the main study addressing the hypothesis, and concludes the hypothesis result based on the prevailing findings.

6.2 RQ 1.1. What is the state of the art in online cancer information seeking; specifically by people affected by cancer in B&H?

Study 1 findings were exclusively used to answer this research question, i.e., H 1.1 1. The dataset was obtained from surveying only the B&H cancer-affected population. The sampled population was predominantly indirectly affected by cancer (61.8%), mainly by breast and lung cancer (16% and 15.3%, respectively). The vast majority (83%) used the Internet to search for health information. The main reasons for cancer information seeking were having someone close diagnosed with cancer (18.2%), and to learn about the diagnosis (general cancer information and cancer types), treatment options and diet and nutrition (see more details in my publications in [298] and [284]).

6.3 RQ 1.2. What is the state of the art of personalisation adoption on web-based health services and specifically by online health service users in B&H and the UK?

This research question was also addressed by Study 1, by evaluating a sample of existing B&H and UK websites on the type of personalisation they have adopted (H 1.2 2) and the target user preference for personalisation services (H 1.2 3). The findings (see details in

[284]) generally show that advanced personalisation has not been adopted on either B&H or UK health websites, while, on the other hand, users would like to be offered a variety of personalisation features. These findings are further discussed in Chapter 8.

6.4 RQ 1.3. Do cancer website users prefer personalisation? Do users perceive a personalised cancer website as more usable?

The PORT cancer website with generic personalisation (Phase I and II versions) was evaluated in Study 2 and 3 to answer this research question.

6.4.1 Overview of methodology

Study 2 was designed as a comparison between PORT's original non-personalised website (labelled *version 1* in the experiment) and the Phase I personalised PORT website developed for this research (labelled *version 2*). The experiment was described in Chapter 4, Section 4.4.1. In **Study 3**, two participant groups used different versions of the PORT website. A detailed overview of the experiment was provided in Chapter 4, Section 4.4.2. The *group 1 (CG1)* participants – treatment group - were instructed to interact with the personalised version of the PORT website [290]. The *group 2 (CG2)* participants – control group - used the non-personalised/default version of the same PORT website [290].

The *Study 2 and Study 3 samples* were explained in Chapter 4, Section 4.2. The Study 2 **dataset** consisted of 79 cases. In Study 3, a detailed, manual review of the *datasets* indicated that some respondents either did not interact with the website, or were giving unengaged responses (straight-lining). Furthermore, respondents who claimed they were not affected by cancer in any way (classified themselves into the category 'None of the above') were excluded. Thereby, the cleaned *CG1 dataset* (122 responses collected) contained 98 cases, and the *CG2 dataset* (22 responses collected) contained 19 cases. The response rate for CG2 was very low, which was one of the limitations of the findings obtained from Study 3.

Reliability of the instrument used to measure the *usability* factor (the same instrument was used, consisting of 7 items) was high in both studies:

- Study 2: Cronbach's Alpha was $0.88 > 0.7$ threshold [319, 320]
- Study 3: Cronbach's Alpha for CG1 was .78 and for CG2 was .89.

6.4.2 Participant demographics

The average *age* of *Study 2 respondents* was 25.8, with a balanced representation of *males* (49.4%) and *females* (50.6%), and all were from B&H. In reporting on how and whether cancer had affected their life, the majority stated that their *family member(s) had cancer* (33.3%), or that they were *interested in cancer information*, but were not (in)directly affected (33.3%). In *Study 3*, the target population consisted of all categories of cancer-affected people (but mainly had a *family member as a cancer patient*), participants were from B&H as well as *other countries*, of average *age* 27 (more detailed *Study 3* demographics are provided in Chapter 7).

6.4.3 H 1.3 4. A personalised cancer website is perceived more usable than a non-personalised one.

A one-sample Wilcoxon signed rank test and descriptive statistics applied to *Study 2* data showed that the median *usability* ($p = .000$; median = 3.86, SD = .84) was significantly greater than a neutral score (i.e., 3). Hence, the *personalised version of the PORT website was overall seen as more usable than the original non-personalised website*.

However, in *Study 3*, where only the *PORT* website developed for this research was used, the results were not as conclusive. An independent samples Mann-Whitney test indicated that the *usability (CG1) of the personalised website* was not significantly different from the *usability (CG2) of the non-personalised version* ($U(117) = 927$, $Z = -.03$, $p = .98$). Nevertheless, interesting patterns were revealed in exploring the *Study 3* descriptive statistics. The website with generic personalisation had a higher overall

usability (CG1: mean = 3.82, SD = .63) than the non-personalised website (CG2: mean = 3.76, SD = .75).

Participant comments gathered in Study 3 give a more detailed insight into user perception about personalisation. *CG1 comments more often praised the personalised website.* In a negative CG2 comment, a participant identified the main issue of the *non-personalised website version*, as follows:

“The major disadvantage of the PORT website [the non-personalised version] is the *lack of better visuals* and user/friendly features such as *larger fonts for more relevant topics, something that would catch my attention! Perhaps adjust the website format to target separated audiences - those having cancer, those having someone with cancer and those only looking for information.*”

The suggested functionalities were the *main advantages of the personalised website version*, including content recommendations tailored to specific user needs and interests, as well as features related to adapting website links, text size and colour.

While *usability of the personalised website was on average higher*, there was not sufficient evidence that the usability of the two website versions differed significantly. Therefore, **H 1.3 4** hypothesis *could not be fully supported*.

6.5 RQ 1.4. Do cancer website users prefer emotion-based personalisation?

The PORT cancer website with emotion-based personalisation (Phase III and IV versions) was evaluated in Study 4 and Study 5 to answer this research question.

6.5.1 Overview of methodology

Study 4: In the Study 4 *experiment*, all participants used the three versions of the PORT website: **DEF** (<http://dev.port.org.ba/>) – default or non-personalised, **PRE** (<http://new.port.org.ba/>) – with generic personalisation, and **EXT** (<http://dev.port.org.ba/>)

– with emotion-based personalisation. The methodology of this study was explained in detail in Chapter 4 (sampling - Section 4.2 and experiment design - Section 4.4.3).

To gain a better understanding into target user preferences for emotion-based personalisation, four people affected by cancer, from B&H, were interviewed in Spring 2016, within Study 4. They were asked for *feedback on: negative and positive impressions about each website version, and which version they would choose to use and why*. A detailed description of the interview procedure and participant responses is provided in Appendix I.

Study 5: Interviews were also carried out in Study 5 (see Chapter 4, Section 4.3.2, for methodology and Appendix J for interview procedure and questions). However, the focus was exclusively on current or former cancer patients, who were familiar with the PORT website. The aim was to explain the obtained research findings.

In Study 5, user preferences for emotion-based personalisation on cancer websites were evaluated in **Experiment 3** (see Chapter 4, Section 4.4.4). Participants were asked to use *two versions* of the PORT website labelled as: **P** - *prior, generic, personalisation*, and **E** - *emotion-based personalisation*. Moreover, a part of the participants evaluated the websites from the perspective of an *existing (revisiting)* user - *Case CB*, and others from the perspective of a *new* user - *Case CF*. This measure was taken to account for the possible differences in personalisation resulting from the applied filtering techniques, as well as to consider the slight variations in the appearance of the PORT website at different development stages (i.e., comparing Phase II version and Phase IV version).

In **Case CB**, the website with content filtering was evaluated. Hence, in using each website version, users were first instructed to rate some content items, then to log back in to review the changes in content recommendations. The *experiment procedure* was described in detail in Chapter 4 (Section 4.4.4). Moreover, in Case CB, two website domains were used:

- E version was tested on www.port.org.ba – the latest PORT website (Phase IV version);

- P version was evaluated on new.port.org.ba – an earlier PORT website with only generic personalisation (Phase II version).

In *Case CF* (collaborative filtering), all participants *visited the same domain*, the latest PORT website (www.port.org.ba). Reporting emotions determined whether generic or emotion-based personalisation was provided. Hence, in experiment tasks for the *E version*, participants were instructed to *report emotions* at login, which resulted in *emotion-based personalisation and adaptation*. While experiment tasks for the *P version* specifically instructed *not to report emotions* after logging in or during use; thereby, only *generic personalisation* was provided on the website. In comparison to Case CB, the ‘new’ users were asked to complete their user profile information, including their interests, which equally affected content recommendations provided on E and P versions.

6.5.2 Data description

Data pre-processing was applied to Study 4 and Study 5 datasets. *Missing values* were present in Study 4 data and were dealt with by replacement or denoting the missing value with a discrete number, e.g. -1 or 99. In Study 5, questionnaire responses were mandatory. Additionally, Study 4 data was cleaned of *straight-lining*. 32 unengaged responses were detected. Two cases were deleted, as straight-lining was present throughout all the questions. Other cases were replaced using average or median. All respondents were taken into account, irrespective of whether and how cancer affected them, because participation in the experiment was based on *assuming the role of a person affected by cancer*, from the very start of website use. In Study 4, in some instances, participants only provided responses for one of the website versions; thereby their evaluation of the other two levels of personalisation was not obtained. These responses were preserved; however, they could not be used completely (e.g., in inferential tests for mean/median comparison) in answering RQ 1.

In Study 5, of the forty responses collected, six were discarded, due to: lack of interaction with both website versions, not following the experiment instructions, or the respondent

not being affected by cancer or interested in cancer information. The final *cleaned datasets* consisted of:

- Study 4 - 125 cases;
- Study 5, Experiment 3 - 34 cases.

6.5.3 Participant demographics

Study 4 participants were mainly *female* (65.6%), of average *age* 25.8, and affected by cancer via a *family member* (37.7%) or interested in cancer information (35.2%). Country of residence of the majority was Jordan, followed by B&H, and the US. The majority of the *Experiment 3* participants in *Study 5* had *family members* (64.7%) or friends (20.6%) who had or have cancer. The rest of the participants were not personally affected by cancer, but preferred to be cancer informed. More detailed demographics are provided in the next chapter – Section 7.2.3.

6.5.4 H 1.4 5. Users find the cancer website with emotion-based personalisation more usable than the website with generic personalisation, and the latter more usable than the non-personalised website.

Based on the comparison tests, *the differences in usability between the evaluated personalisation versions were not significant*. Repeated measures ANOVA, with sphericity assumed, showed in *Study 4* that the *usability* ($F(2, 186) = .895, p = 0.41$) of the website without personalisation, with generic personalisation and with emotion-based personalisation, was not significantly different. Wilcoxon signed ranks test in *Study 5* also indicated that the difference between E and P website versions' usability was not significant ($Z = -.492, p = .623$).

However, the *descriptive statistics* for both Study 4 and 5 indicated that the *usability score* for the website version with *emotion-based personalisation was the highest*. Hence, the website versions can be ordered as follows:

1. Website with *emotion-based personalisation* (Study 4 EXT version: median = 70, mean = 68.1, SD = 14.3; Study 5 E version: median = 76.3, mean = 71.7, SD = 18.8)
2. Website with generic personalisation (Study 4 PRE version: median = 67.5, mean = 67.3, SD = 14.3; Study 5 P version: median = 75, mean = 74.4, SD = 18.6)
3. Non-personalised website (Study 4 DEF version: median = 67.5, mean = 66.2, SD = 15.1)

SUS [220] reports that the score of **68** is a benchmark, whereby scores higher than 68 imply an above average usability. Importantly, in Study 4 of my research, *only the website with **emotion-based personalisation** had an above average **usability** score* (mean = 68.1; median = 70). In Study 5, both of the evaluated website versions had an above average usability. However, 76.5% of users considered the usability of the website with emotion-based personalisation to be above average, in contrast to the 70.6% who gave an above average usability rating to generic personalisation.

6.5.4.1 Study 4 Interview

Additionally, *interviews* were carried out with the target users to obtain a more detailed insight into user opinions about the three personalisation options. The Study 4 interview findings are summarised next, and a detailed report is provided in Appendix I.

Interview results implied that a cancer website with some level of *personalisation* was the users' preferred choice, particularly *emotion-based personalisation*. The *website with **emotion-based personalisation*** (EXT) was preferred by **two** interviewees. Both participants expressed definitive preference for personalisation on a cancer website. The interviewee IntTHS claimed with certainty that he preferred the most the EXT version. While the interviewee IntSNK was not as decisive; she liked both personalised versions, but expressed a slight preference for using the EXT version and recommending it to a friend.

EXT was mainly preferred for the following reasons:

- having *recommendations*; the website providing content recommendations based on user provided interests, emotions and other data
 - the website thus appears to have more content, which is more easily accessible;
 - recommendations were perceived positively because they guide users to information they might not otherwise be aware of, notice or remember to search for;
- having *features highlighted* - being guided to what a user is interested in, having features distinctly marked so they are easily found;
- having *more features* (options) available;
- *profile page* providing everything in one place;
- *reporting emotions*, particularly at rating;
- being more *convenient* for frequent users of cancer websites.

However, interviewees also identified a level of *apprehensiveness about emotion-based recommendations*. This attitude was formed, in part, due to their lack of understanding of the system's functionality, and the fear that emotions might lead them away from important information. As IntTHS expressed:

“In the case of someone who has just learned he is ill, and therefore experiences negative emotions, will the website lead him only to the part of the website shown to people who feel negatively? However, such a person might be interested in finding out all about his illness, and maybe the website that filters information based on emotions will prevent him from reaching all the desired knowledge.”

Interestingly, while feature highlighting was a positive aspect of this website version, interviewees disliked the dark purple as the *colour choice* to highlight links. Therefore, colours used for highlighting were refined in Phase IV of website development (green was used instead). *The fact that participants noticed the colour changes resulting from adaptation, and liked them, could suggest an agreement with the adaptation received.*

The ***website with generic personalisation*** was the second preferred choice. **One** participant preferred this version, but in comparison only to the default version. IntSUS

used only two website versions; she had limited available time, experienced slight anxiety towards using computers, and claimed that viewing the computer screen irritated her eyes. In essence, IntSUS expressed a *preference for having personalisation on a cancer website*.

The *positive* aspects that all four interviewees identified for this website version included: nice *design* and arrangement of the user interface; appearing more complete, integrated, finalised; *easy to use*; has many desired features; and useful *recommendations*. On the other hand, the *negative* aspects were: greater *complexity*; functionality of the Emotion Tool – it did not open automatically, users were unlikely to click on it, and it opened without users wanting it to when accidentally hovering the cursor over it; and the website lacked certain features, such as contacting a psychologist.

The *website without personalisation* was preferred by **one** interviewee, for the following reasons: simplicity and ease of use; and design, the colours not being intrusive. This version was considered a better choice for a *quick information search for a one time*, infrequent visitor. On the other hand, the interviewees claimed the *negative* aspects were that it *lacked personalisation* and that it was less usable, as it lacked the majority of useful features, e.g. rating, virtual community, recommendations and adaptation features.

6.5.4.2 Study 4 Survey Comments

Additional *user feedback* was collected via the *Study 4 survey questionnaires*, which allowed the participants to comment on each of three website versions they interacted with. *Fifty seven participants* provided comments for at least one of the website versions they evaluated.

Manual analysis of the textual data revealed that users were almost entirely focused on the availability of cancer-related content or lack thereof - possibly as website content may be the target users' main concern. They, hence, often failed to pay attention to the main aim of the experiment - to notice the distinguishing levels of personalisation. One of the

participants (Par8) summed up the main issue – *the need to have a longer exposure to the personalised website*, in the comment for the EXT website version:

“I don't think I had enough time to understand the types of personalisation that were being provided to me. I think I would need more time in the system, and more 'real-world' usage in order to experience the changes in the content.”

Participant comments clearly show *they failed to distinguish between the websites*; they would either give one comment referring to all three versions, or three comments of similar nature. Often, the feedback was very generic, and addressing aspects that were the same for all website versions, for example: *lack of content, content mainly in Bosnian, the website being inactive, or it being a simple website, easy to navigate, with a nice design*, etc. Some participants commented on how satisfied they were with the content on one website version, but not on the other. For example, Par1 (translated from Bosnian):

Comment for EXT: *“...the amount of content is minimal. I expected more information about the illness itself, symptoms, treatment and patient experience.”*

Comment for PRE: *“I am pleasantly surprised by the more extensive content on this website.”*

Moreover, comments related to the lack of content were more frequent for the personalised website versions, where it would be expected that content recommendations would imply greater relevance and accessibility of content. Nevertheless, in designing the Study 4 experiment, it was ensured that all website versions had the same amount and type of content, so that it would not be the factor affecting the difference in perception about the website versions.

The participants who stated they *preferred the website version with emotion-based personalisation* (Phase III PORT website) gave the following reasons (direct quotations):

Par9: *“After going through all websites I definitely have to say that grey one [EXT] was the best, most interesting and somewhat nice to use. It was a bit personalized and*

I like how I could see forum and chat immediately because I think this is one of the most important things when it comes to these and similar websites.”

Par10: *“I found this version of the web site far more useful. The best features for me include background changing color, making it more pleasant and filtering the articles based on my stated interest.”*

Par11: *“I liked the expanded emotion tool...”*

Par12: *“The good news is that the interface itself is extremely well-designed, and very user friendly with loads of potential to be a fantastic website.*

Some of the participants also pointed out what they perceived were the *negative aspects* of the EXT version (Phase III PORT website). Hence, Par12 further continues in the comment:

*“Unfortunately, that is where the positive feedback ends. The article recommendations in my profile had absolutely nothing to do with my previous searches, and even when I deselected the option to show information about women's cancer, the *only* recommendation in my profile remained an article about food related specifically to women and cancer. This was, overall, a very frustrating task¹² that took **significantly longer** than anticipated... Moreover, 90% of the time I updated my emotions and click "save" -- it did *not* correctly save, the panel immediately popped back up, and I had to redo it again.”*

Interestingly, even though the comment gives an impression the user is frustrated, Par12 was the only participant that additionally contacted me via e-mail and offered his assistance in identifying the system bugs, due to his interest in this type of a cancer website. Indeed, the Phase III PORT website had several bugs in the functionality of the Emotion Tool. Due to this, a few users claimed to have experienced the Emotion Tool to reappear immediately after having reported emotions. The Emotion Tool issues were repaired in the Phase IV website version. Moreover, the interests-related optimisation of

¹² Par12 was recruited via AMT crowdsourcing service, hence the reference to a ‘task’.

content recommendations was introduced in Phase IV. In Phase III, the filtering of recommendations based on user interests was not as strictly defined.

Overall, user comments were helpful for identifying website services which needed further improvement, which was accomplished in Phase IV of website development. Moreover, the comments highlighted areas of the experiment design which needed adjustment. Hence, several refinements were made in *Study 5*. For example, Study 5 experiments included a statement informing participants that the website's content is not the focus of the evaluation, but its features.

6.5.4.3 Study 5: User comments and interview findings

Users also commented on their experience with the latest version of PORT website (Phase IV version). The positive and negative aspects of the website were extracted from the comments.

Hence, users had a positive attitude to the *emotion-based recommendations, highlighting and the presence of the Emotion Tool*. They claimed: “*Tailoring the suggestion to emotions is a good idea*”; “*I think the emotional tool may be very useful*”. One of the participants nicely summarised the general opinion about the latest website:

“I think it a well thought out, well planned website, that offers *ease of use*, as well as *predictive articles*, to help better serve you with the *features that you specifically require*.”

However, users also identified several *negative aspects*. These were related to the website appearance and browsing, for example: “The *appearance* of the site is perhaps *slightly too complex for fluid browsing*”. Users who have not noticed that they can select the *language* of the website, or have not paid attention to the statement in the experiment informing that the content should not be the main focus in evaluating the website, claimed the following: “the site *should discriminate between whether or not the user comes from an English speaking country*”; “would be helpful if the website could *remember language preferences/settings*”.

The negative sentiment in other comments was expressed toward the recommendations, adaptation, and particularly the use of the Emotion Tool. These users claimed:

“The recommended content section didn't really reflect the affective state of the user.”; “I did not notice a significant difference in proposed article and some suggestions were unfortunate...”; “maybe the highlighting goes a bit unnoticed”; “I think it may become a bit boring because it has so many emotions. My suggestion is to have an emotional tool with less emotions to classify.”; “Instead of having the emotion tool pop up every time you read or click on a link/article, maybe have an easy access button that offers you to record your affective state at that point.”

According to these comments and the Study 4 interview findings, users overall liked the concept of the website, its design and the content recommendations. Nevertheless, they identified the following issues or aspects they disliked:

- Usability issues with certain features; for example having to select language preferences or Emotion Tool appearing automatically and having too many emotion options.
- Adaptation and personalisation to emotions not being noticeable, i.e. design of the highlighting adaptation.
- Content recommendations not matching user needs sufficiently, particularly not being distinguishable in different affective states.
- Moreover, emotion-based personalisation potentially guiding away from important content.

Nevertheless, addressing some of these aspects *would require longer usage of the website*. A revisiting user who has clearly defined their interests, who has expressed content preferences by rating a certain amount of content, who is accustomed to the general appearance of the website and has received certain type of recommendations in the same affective state, would not receive topic recommendations they are not interested in, would be more likely to observe the changes in content recommendations resulting from different emotions, as well as notice the highlighted parts of the website.

Therefore, in *Study 5*, interviews with repeat visitors to the PORT website were performed. Based on these interviews (further reported in the next section and Appendix J), users found the latest version of the PORT website (Phase IV version) easy to use. IntTHS claimed: “*Everything is offered. There is nothing complicated here. Everything is simple.*”

6.5.4.4 Hypothesis result

In conclusion, the data ***did not support*** the ***H 1.4 5*** hypothesis. Usability of the three versions of personalisation that were evaluated in this research was not significantly different. However, the website with emotion-based personalisation had a higher usability score than the websites with generic or no personalisation.

6.5.5 ***H 1.4 6. Users of cancer websites prefer emotion-based personalisation to generic personalisation services.***

In Study 2 – 4 comparison between the levels of personalisation was only based on website *usability*. However, in Study 5, users were also asked to explicitly express their *preference* for a website version. The 4-AFC questionnaire protocol [179, 248] was used (see Chapter 4). Thereby, participants could state a preference for one of the website versions, equal preference or equal dislike for both versions.

Binomial test ($p = .856$) and one-sample Chi-square test ($p = .715$) showed that the mean proportions of users who preferred the website with *emotion-based personalisation* (Version E) and those who preferred *generic personalisation* (Version P) were not significantly different. Preference for websites with emotion-based or generic personalisation occurred with equal probabilities.

However, the findings showed that a narrow majority of users (47.1%) preferred Version E to Version P (40.1%). The remaining responses (11.8%) were neutral, i.e., preferred both versions. Overall, nevertheless, a *significant preference for emotion-based*

personalisation over generic personalisation on a cancer website could not be claimed. Hence, the **H 1.4 6** hypothesis was **not supported**.

6.5.5.1 Study 5: Interview and focus group findings

Study 5 interview data suggests that *repeat visitors*, who grow accustomed to reporting emotions and become aware of the effect emotions have on website personalisation and adaptation, ***prefer the website with emotion-based personalisation*** over the other options. This section provides excerpts from interviews with two cancer sufferers – IntTHS and IntLA. The first interviewee is male, in his early twenties, a former cancer patient, who battled osteosarcoma, and is from B&H. IntLA is a current cancer patient - treated for Non-Hodgkin's lymphoma; she is female, in early thirties, and from B&H. The description of the Study 5 interview procedure is available in Appendix J.

Both interviewees claimed they preferred the website version with emotion-based personalisation. IntLA justified her choice mainly for her preference for a variety of features, and a level of control provided to the user. Hence, she stated:

The third [emotion-based personalisation version] that has all the options offered... I always support giving the user as many options as possible. To give them a choice, [...] and to have the highest level of control, over content and recommendations.

When asked about her experience with reporting emotions on the website and when she was able to realise the effect of emotions, IntLA stated:

I think only after using the website a few times. The first time it was more of – Oh! Why is it asking me this? Why do they want to know my emotions at that moment? However, I realised in using the website that it is beneficial, as I receive the content that is of greater interest to me... I think it reduced the information search time.

IntTHS also claimed he would choose the website with emotion-based personalisation, particularly because of the additional level of personalisation. However, he still perceived that the basis of personalisation should be user interests. Hence, IntTHS stated:

I like the most the version with emotions, because you can really personalise. I know what I searched for in a certain mood and when I visit again, it will offer me what I am really interested in. The other one which is based only on interests is also good, but the one with emotions offers more personalisation. At the start, I believe being able to choose what interests me is the most important. But I also like emotions, because they help the website recommend me what I want.

I think this website will be more useful to people who are facing a problem [cancer] than those who just came to inform themselves. [...] If you are facing a problem, you are interested in things beyond just that problem, [...] and when your emotions change you might want to be exposed to other information.

When asked whether there could be a difference in how first time users see emotion-based personalisation compared to the users who become familiar with the website, IntTHS further stated:

Well, it is a new thing for them [first time users]. You know, people do not like change. [...] So when users see this [reporting emotions] they think – Well! I don't know, I have never used this... But, if they were to use it, maybe they would understand that, in things like this [cancer website], it helps. If they were to become more familiar with the website, they would understand better what it is about and why certain features are offered.

The interviewees were further asked for an opinion on why the preference for emotion-based personalisation on a cancer website was not significant, based on my research findings. Both interviewees pointed towards users' unwillingness to report emotions (for privacy or fear reasons), as well as having apprehensiveness towards the unfamiliar, that which they have not seen on other online services. IntLA suggested that users might not consider the website with emotion-based personalisation as not useful, but rather that they might not want to provide information about their emotions, out of fear. Hence, IntLA stated:

Perhaps it has to do with the personality type of a user. Or...how much time they want to spend on the website. People have limited time... A person might need to invest

more time when they are reporting emotions, when reviewing content... It probably also has to do with how well in-touch with yourself you are, how well you can reflect on your own emotions, to be able to report them here. There might also be a barrier towards providing such information. Privacy...

Similarly, IntTHS claimed that the lack of a clear preference for emotion-based personalisation could be the result of:

Possibly because the majority of people believe once they state their cancer interests, it is enough, that they will always seek the same. They are not interested in emotions because they think they are redundant. They might think – what does it matter if I am in a good mood or not? I know I am interested in...for example...breast cancer. [...] Perhaps people fear – What if I am angry, and I click that I am angry, maybe it will show me something that is not for me?... But, they most probably think that way due to lack of knowledge.

And also because the majority of websites that people use, especially in Bosnia, I have not yet seen any of them offering emotions. So it might be something new.

Focus group: Furthermore, the five young, adolescent, cancer survivors who participated in the **focus group** meeting were also *more inclined towards the **website with emotion-based personalisation***. I demonstrated all three website versions, and showed their common characteristics, as well as the features they differ in – particularly the different levels of personalisation. *Three* of the participants expressed they *preferred having emotion-based personalisation* on the cancer website. *One girl* claimed she liked the use of emotions, and the emotion-based content filtering, however would like to have the option to disable the emotion-based personalisation when she did not feel like reporting emotions. Finally, *another girl* claimed she preferred the website with generic personalisation. She believed obtaining personalisation based on her interests was more relevant. She did not per se express negative sentiment towards having emotion-based personalisation; instead she claimed that such an option was interesting, but not her preferred choice.

6.5.5.2 Hypothesis result

In conclusion, the statistical tests did not show a significant difference in preferences for emotion-based personalisation, hence, they **did not support H 1.4 6**. However, more users did prefer this website version. Furthermore, interview findings suggest that repeat visitors, particularly those facing cancer at the specific time, are more likely to see the benefits of emotion-based personalisation, and therefore prefer it over other personalisation options.

6.5.6 H 1.4 7. *In the same aggregated affective state, users find a website with emotion-based personalisation the most usable, followed by the website with generic personalisation, and lastly the one without personalisation.*

After exploring the perceived usability of the three approaches - emotion-based, generic personalisation and no personalisation - I looked into the impact of emotions on these preferences. Interestingly, based on descriptive statistics applied to Study 4 data, aggregated affective state could reflect on how usable the different levels of personalisation are perceived.

Summary statistics in Table 6.1 show that in *NAAS*, users found the website with *generic personalisation* the most usable, followed by the website with *emotion-based personalisation*. In the **neutral** aggregated affective state, users seemed to prefer the website *without personalisation*, while the second preferred was *emotion-based personalisation*. However, the number of responses for the neutral state is very low, thus is a limitation in interpreting the results.

In *PAAS*, which provides the most reliable findings, due to sufficient responses, users considered the website with ***emotion-based personalisation*** the most usable, followed by the website with ***generic personalisation***. In *PAAS*, the website ***without personalisation*** was found the least usable. Therefore, the hypothesis **H 1.4 7** was ***partially supported*** for the *PAAS*. However, inferential tests were not applied to this hypothesis, therefore, the results are only indicative, as they are based on descriptive statistics.

Table 6.1. Summary statistics for usability compared between the three website versions

Pre-use aggregated affective state	Usability of DEF version			Usability of PRE version			Usability of EXT version		
	Mean	N	SD	Mean	N	SD	Mean	N	SD
Positive (PAAS)	65.61	86	15.29	66.79	85	13.54	66.84	98	15.28
Neutral	80	3	13.23	68.75	2	33.59	72.5	3	6.61
Negative (NAAS)	68.33	9	12.87	72.78	9	17.02	69.17	9	21.54
Total	66.30	98	15.13	67.4	96	14.19	67.18	110	15.62

6.6 RQ 1 Summary

A comprehensive discussion of the findings for RQ 1 is provided in Chapter 8. The results are briefly summarised here.

Different methods and experiment designs were used throughout this research to measure user preference for a certain type of personalisation. My findings imply that introducing personalisation (general services or emotion-based) is not perceived as a significant improvement to cancer website usability. Nevertheless, users generally gave higher usability ratings to the personalised websites. Particularly, the website with emotion-based personalisation received above average usability scores and was preferred by a larger number of users. Moreover, interview data indicated users mostly desired emotion-based personalisation on the PORT cancer website.

The next chapter reports the findings for the conceptual framework relations. Chapter 7 presents the results of hypotheses tests that respond to RQ 2, i.e., whether emotions influence user perception of personalisation and cancer website reuse intentions.

Chapter 7

Results for RQ 2: Conceptual framework relations

Chapter 7 addresses data analysis and findings for the *second research question* on – *whether emotions influence the perception about cancer website personalisation and intentions to reuse the website* (RObj4 and RObj6). The combined results are shown in Appendix H. The appendix maps the individual hypotheses to a specific study, and highlights whether they were supported, partially supported, or not supported.

RQ 2 was also addressed by all the five studies. One of the main reasons the research was divided into a number of studies was that the conceptual framework (the primary focus of RQ 2) was re-evaluated with the introduction of new research factors, different relations between the factors, as well as using alternative instruments to measure them. This required collecting additional data and carrying out experiments with different designs.

7.1 Description of research

A brief overview of each of the studies follows. Chapter 4 reported on the studies' designs and methodologies.

Study 1 sought to establish whether emotions stimulate online behavioural intentions of the cancer-affected people (RQ 2.1.3, Table 3.2). **Study 2** was the first to test the *research model*. **Study 3** focused extensively on the associations between emotions and usefulness of personalisation features, and introduced the factors – satisfaction and preference for a personalisation approach.

Study 4 tested the refined research model associations. *It most comprehensively addressed RQ 2*; it covered all the research sub-questions the previous two studies looked into. **Study 5** was a *follow-up* to the findings of the previous studies, specifically the influence of emotions on usefulness of and use of individual features and content. As explained in Chapter 4 (Section 4.4.4), Study 5 was divided into three experiments, of

which Experiment 1 and 2 addressed RQ 2. In **Experiment 1**, participants interacted with the latest version of the PORT website (Phase IV website) and evaluated the *usefulness of individual features and content of the website*. In **Experiment 2**, *user interactions* with the latest PORT website with emotion-based personalisation were recorded.

In summary, Studies 2 - 5 explored the research model relations, with respect to the *usefulness of personalisation features* (RQ 2.1.1, RQ 2.1.2, RQ 2.1.4), usefulness of and preference for *adaptivity* compared to *adaptability* (RQ 2.2), *satisfaction with personalisation* (RQ 2.3), *website usability* (RQ 2.4), *post-use emotions* (RQ 2.5), and *reuse intentions* (RQ 2.6). The research constructs have been defined in detail in Chapter 3. However, the next two sections address the unique issues encountered in analysing two types of factors: the *emotions-related factors* and the *factors measuring the usefulness of personalisation*.

7.1.1 *Emotions-related factors*

The *pre-* and *post-use emotions factors* in Study 2 – Study 5 were calculated using the same approach. As explained in Chapter 3, this research explored *discrete emotions*, as well as two states that aggregate emotions of the same valence – i.e., *positive emotions mean intensity* and *negative emotions mean intensity*. The number, intensity and classification of emotions depended on the study (see Chapter 3, Section 3.3.2). For example, the 12 emotions explored in Study 3 were classified as:

- negative: fear, sadness, embarrassment, guilt, anxiety, boredom
- positive: excitement, interest, surprise, happiness, awe, calmness.

Thus, the *positive emotions mean intensity* (PEI) was the average of the intensities respondents indicated for positive emotions. And the *negative emotions mean intensity* (NEI) was obtained by averaging the intensities of the negative emotions. See Equation 1 in Chapter 3.

The emotion **surprise** was a unique case among the explored emotions. Surprise has an ambivalent valence, i.e., is considered a neutral emotion [129, 137]. Exploratory factor

analysis (PCA with direct oblimin rotation) showed that in Study 2 and 3, post-use surprise was more correlated with positive emotions, while pre-use surprise had almost equal loading values for the component mainly comprising negative emotions (Study 2: .441, Study 3: .583), and that which comprised the positive emotions (Study 2: .491, Study 3: .580). Therefore, *surprise in Study 2 and 3 was classified and analysed as a positive emotion.*

However, *in Study 4 and 5, surprise was explored as a negative emotion.* The reason I reclassified surprise was that, in the earlier two studies (Study 2 and 3), surprise mainly negatively affected user perception about the usefulness of personalisation features, and it affected reuse intentions as the negative emotions. Moreover, factor analysis indicated it had almost equal loadings for the positive emotions component (pre-use surprise - Study 4: .484; Study 5: .484) and the negative emotions component (pre-use surprise - Study 4: .483; Study 5: .490). Therefore, Study 4 and Study 5 *emotions were classified* [37, 137, 151, 174, 230-232] as follows:

- ***Positive emotions*** included: *interest and joy.*
- ***Negative emotions*** were: *fear, sadness, guilt, shame, anger, disgust and surprise.*

7.1.2 Factors measuring usefulness of personalisation

In Study 4, the factor *usefulness of personalisation features* was measured with 32 items representing the usefulness of 32 individual features of the Phase III PORT website. These items were classified into adaptive and adaptable features, i.e. website services, in order to calculate the constructs - ***usefulness of adaptivity*** and ***usefulness of adaptability***. Some of the evaluated features were general website services (e.g. chatroom, sharing content, commenting, and information bubbles in profile editing), which were thus not either of the two personalisation approaches.

Usefulness of adaptability was measured with *sixteen adaptable services of the PORT website*, as follows:

- Giving feedback (selecting Yes/No) about the usefulness of recommendations and whether user's personal data should be used in generating the recommendations
- Enabling the user to personally customise the website
- Enabling the user to state for every personal data type whether they want it to be used in tailoring the content recommendations
- Defining personal interests for the website profile
- Emotion Tool
- Feature that reminds the user to rate a content - "What did you think about the following content?"
- User profile customisation
- Privacy policy presentation – choosing between long and concise version
- Filtering search outcomes
- Filtering recommended content on user's profile
- Adapting text size
- Adapting text colour
- Personal readlist
- Rating content
- Bilingual content – selecting website language
- Tailoring website background colour

Usefulness of adaptivity was measured by *twelve adaptive services* offered on the PORT website, as follows:

- The website automatically creating content recommendations, based on user interests, ratings, emotions, and other behaviour
- Content recommendations on user's profile
- The website automatically highlighting or hiding features, based on user emotions
- Highlighting or hiding content and features - directing the user to specific website parts based on their emotions
- Forum discussions recommendations (on the Forum pages)
- Blogs recommendations (on the Blogs pages)
- Knowledge base recommendations (on the Knowledge base pages)

- Articles recommendations (on the Articles pages)
- Adaptive storyline – recommending similar content to the one a user selected was useful
- Orange triangle – an icon notifying the user data is missing in their profile
- Red rectangle – a feature notifying the user data is missing in their profile
- Greeting with a user name

Similarly, the Phase IV PORT website features and content types (see Appendix L) evaluated in Study 5 (Experiment 1) were categorised into adaptive and adaptable services. The classification applied to Study 4 items was followed. 16 of the evaluated features were used to measure the usefulness of adaptivity, while 19 measured the usefulness of adaptability.

7.2 Analysis methods and data description

The *statistical tests* used in responding to RQ 2 included: descriptive statistics, reliability analysis and inferential statistics, and manual analysis of qualitative data. The *analysis tools* used were IBM SPSS [317], Microsoft Excel, and Weka [321] tool for data mining. The *statistical significance* cut-off point for all the studies was 0.05. However, to avoid Type I errors, multiple comparisons were dealt with by applying Bonferroni [322, 323] or Holm-Sidak [324] corrections. *Triangulation* was also used in testing the research model relations.

Next described is the *data collected in the individual studies, including the number of data cases, variables, and reliability analysis results*. RQ 2 was tested on the data collected for the PORT website version developed for and evaluated in the particular study; for example, in Study 4, the Phase III PORT website with emotion-based personalisation was used.

7.2.1 Datasets

Data pre-processing was explained in Chapter 4, and in Chapter 6 for the individual studies. The studies' pre-processed **datasets** consisted of:

- Study 2 - 79 cases
- Study 3 - 98 cases
- Study 4 - 113 cases
- Study 5 - 22 cases

The Study 2 – Study 4 *datasets* comprised *user background variables* - *age* (continuous), *gender* (nominal), *how cancer affected the respondent* (nominal), and *country of residence* (nominal; included from Study 3 onwards) - and the factors listed in Table 7.1. The **Study 3** dataset also included the factor *preference between adaptivity and adaptability* (5 nominal variables).

In **Study 5**, two datasets were obtained to test RQ 2. In *Experiment 1*, users evaluated the *usefulness of the PORT website features*. Therefore, evaluations of features' usefulness should have been based on user experience with the features after interacting with them. However, review of activities showed that three participants did not perform the experiment tasks. These responses were removed. Missing values were present in the data and were preserved as missing (e.g., indicated with a -1 value). The cleaned **Experiment 1 dataset** consisted of the previously identified *user background variables* and the items of the *four constructs* specified in Table 7.1. The Experiment 2 dataset is presented in Section 7.6.5.4.

The dataset obtained from the **longitudinal study** is explained in Appendix K. The longitudinal data was used in responding to RQ 2.1.1 and RQ 2.1.4. It showed which website features *repeat visitors* choose to interact with. Moreover, it indicated the *emotions which influence interaction with specific website features in long-term website usage*.

7.2.2 Reliability analysis

The instruments used to measure the constructs explored in this research, overall, had a high reliability (Table 7.1), with Cronbach's Alpha values above the 0.7 threshold [319, 320, 325]. The factors with values below 0.7 were:

- *Study 2 post-use positive emotions mean intensity* - Cronbach's Alpha of .68 was close to the threshold value. Tests with this factor were interpreted with particular care.
- *Study 4 pre-use and post-use positive emotions mean intensity*; both constructs had a *significantly lower or negative Cronbach's Alpha*. The two constructs were measured by two items – interest and joy – which did not indicate a sufficient level of internal consistency. Therefore, *hypotheses tests for these factors were not run or the results were not accepted*.

Table 7.1. Instrument reliability

Constructs	No. of items				Cronbach's alpha			
	St 2	St 3	St 4	St 5	St 2	St 3	St 4	St 5
5-point scale (Study 2: 11 point scale): <i>not experiencing at all</i> to <i>extremely experiencing</i> ; items recorded as <i>ordinal variables</i>								
Pre-use positive emotions mean intensity	5	6	2	2	0.72	0.71	0.39	0.72
Pre-use negative emotions mean intensity	8	6	7	7	0.89	0.79	0.81	0.76
Post-use positive emotions mean intensity	5	6	2		0.68	0.75	-0.002	
Post-use negative emotions mean intensity	8	6	7		0.84	0.74	0.82	
5-point scale: <i>strongly disagree</i> to <i>strongly agree</i> (Study 5: 5-point scale: very useless to very useful); items recorded as <i>ordinal variables</i>								
Usefulness of personalisation features	24	33	32	42	0.93	0.93	0.94	0.94
Usefulness of adaptability			16	19			0.91	.87
Usefulness of adaptivity			12	16			0.84	.9
5-point scale: <i>strongly disagree</i> to <i>strongly agree</i> ; items recorded as ordinal variables								
Usability	7	7	10	10	0.88	0.78	0.87	0.94
Reuse intentions	5	5	3		0.91	0.89	0.86	
Satisfaction with website personalisation		8	5			0.88	0.77	

7.2.3 Summary statistics: Participant demographics

Descriptive analysis was applied to the user background data collected in the four studies. The participants in *Study 2* were *all from B&H*. Their average *age* was 25.8, males (49.4%) and *females* (50.6%) were relatively equally represented, and the majority had a *family member(s) fighting cancer* (33.3%).

The average *age* of *Study 3* respondents was 27 (SD 8.85, range: 18 - 57). *Females* were more represented (61.2%). The study's participants were from *12 countries*. The majority were from *B&H* (51%), followed by the US (33.7%). The remaining countries (1 or 2 respondents) included: Turkey, Serbia, the Netherlands, Malaysia, Jordan, Germany, Italy, the UK, Slovakia, and Slovenia. Most of the participants were *caregivers to a family member who suffered from cancer* (54.1%). Others reported being interested in informing themselves about cancer (30.6%), or having a friend who had cancer (14.3%), or were a cancer patient (1%).

Study 4 sample was also slightly homogeneous, as *females* were the majority with 65.6%. Average *age* in this study was 25.8 (SD = 10.4, range 17 - 69). *Country of residence* of the majority of respondents was *Jordan* (59 participants). 34 participants were from B&H, and 20 from the US. Other countries included: UK (7), Switzerland (2), China, Malaysia, Croatia (1 respondent each). 37.7% had a *family member suffering from cancer*, 35.2% were interested in cancer information, 14.8% had a friend cancer patient, 8.2% did not place themselves into any of the provided categories, 4.1% were current/former cancer patients. In this study, responses of participants who placed themselves into the *None of the above* category were preserved within the dataset, as all participants were instructed to *interact with the PORT website by assuming the role of a cancer-affected user*.

Study 5 (Experiment 1) *participant demographics* show that responses from the *UK* and *Italy* were the most frequent (4 participants each), followed by B&H (3), US, Germany and Malaysia (2 participants each), and France, Serbia, Spain, Portugal and Turkey (1 participant each). *Females* (54.5%) and males (45.5%) were relatively equally represented. The average *age* of participants was 30.3 years (SD 3.92, range 24 - 39). The

vast majority (54.5%) were *affected by cancer via a family member*. 4.5% were also indirectly affected via a friend. The remaining 40.9% were interested in raising their cancer awareness. The responses of participants who claimed to belong to the *None of the above* category were not considered.

The results of hypotheses tests are next presented. The results are organised around the research questions they answer.

7.3 RQ 2.1.1. Do users perceive personalisation features introduced to a cancer website as useful?

This research hypothesised under H 2.1.1 1 that *people affected by cancer perceive personalisation features they are offered on a cancer website as useful*. User evaluations of the PORT website with different levels of personalisation (Phase I – Phase IV website versions) served in answering this hypothesis.

The *H 2.1.1 1* hypothesis was **supported** by data in all four studies (Study 2 – Study 5). On average, participants perceived *the personalisation features* they were offered on the PORT website as *useful*. User rating for the factor *usefulness of personalisation features* was significantly greater than neutral, according to:

- Evaluations of the website with emotion-based personalisation (Study 4: mean = 3.58, SD = 0.67; $t(112) = 9.126$, $p = .000$; and Study 5: mean = 3.94, SD = 0.4; $t(21) = 11.06$, $p = .000$ and Wilcoxon signed rank test $p < 0.001$)
- Evaluations of the website with generic personalisation (Study 3: mean = 3.83, SD = 0.5; a one-sample Wilcoxon signed rank test $p < 0.05$)

Furthermore, Wilcoxon signed rank tests established that the majority of the ***individual personalisation features*** were rated as *significantly useful*. Detailed findings are presented in Appendix L. The appendix provides bar charts with the distribution of usefulness ratings for the individual features. Moreover, it *highlights how useful the*

emotion-based personalisation features were rated (H 2.1.1 2) in the last two studies, and provides further explanations extracted from interviews and user comments.

The findings of this research indicate that users were *mainly **neutral** about the usefulness of the following features* (in bold are those that were rated as neutral or not useful in several studies):

- **tailoring website background** (colour) (Study 5, Study 2 (rated as useless))
- **adapting text colour** (Study 5, Study 2)
- **greeting with username** (Study 5, Study 2)
- reporting emotions (Study 5)
- “What did you think about the following content?” (Study 5)
- red rectangle notifications (Study 5)
- forum discussions recommendations (Study 5)
- personalised e-mail notifications (Study 2)

On the other hand, the following features were considered *the most **useful** features* to have on a personalised cancer website. Features in bold were rated among the most useful in several studies:

- **article recommendations** (Study 5; Study 3; Study 2; Study 4 and Study 5 website interaction data; Study 4 interview)
- **content recommendations** displayed on the user profile page (Study 4; Study 4 and Study 5 website interaction data; Study 4 interview)
- **knowledge base recommendations** (Study 3; Study 4 and Study 5 website interaction data; Study 4 interview)
- “**Is this a useful recommendation for you?**” (Study 4, Study 5)
- **adaptive storyline** (adaptive navigation – direct guidance) (Study 4, Study 2)
- **Emotion Tool** (appearance) (Study 4, Study 4 interview)
- **defining personal interests** (Study 4, Study 3)
- **rating content** (Study 4, Study 3)
- **filtering content** by cancer type (adaptive navigation – sorting links) (Study 5, Study 2)

- **search outcomes presentation** (Study 3, Study 2)
- **selecting language / content in native language** (Study 4, Study 2)
- **commenting** (Study 4, Study 3)
- "Why recommended?" (Study 5)
- feature highlighting, specifically highlighting content recommendations (Study 4 interview)
- enabling the user to personally customise the website (Study 4)
- readlist (Study 2)
- greeting with a username (Study 4)

Importantly, some of the top rated useful features are related to personalised content recommendation, as well as emotion-based adaptation. These were for example: article and knowledge base recommendations, recommendations on the user profile page, providing feedback about the usefulness of a recommendation, explanation why a recommendation was made, the Emotion Tool and highlighting features.

7.4 RQ 2.1.2. Do background characteristics influence user perception about the usefulness of personalisation features?

H 2.1.2 3 addressed this RQ by hypothesising that *user background characteristics* – such as age, gender, the country a user is from, or how cancer affected their life - *influence the perception about the usefulness of personalisation features*.

A significant positive, but weak, relationship with *age* ($\rho = .21, p = .039$) was found in Study 3. The main findings were reached in Study 4. An independent samples t-test indicated that *gender* influenced the perception about the *usefulness of personalisation features*. Male participants gave a significantly *lower usefulness score* ($3.34 \pm 0.63, N = 36$) compared to females ($3.72 \pm 0.62, N = 74$), a mean difference of 0.37 (95% CI, 0.12 to 0.62), $t(108) = 2.95, p = .004$.

How cancer affected the user also significantly influenced the perception about the *usefulness of personalisation features* ($F(4, 105) = 2.72, p = 0.033$). *Current/former*

cancer patients (3.0 ± 0.14 , $N = 5$) perceived personalisation significantly less useful than users whose *friend was a cancer sufferer* (3.95 ± 0.33 , $N = 15$). As further discussed in Chapter 8 (Section 8.3.2.1), it is likely that people directly affected by cancer are personally vested in the cancer topic, and thus more critical of cancer website services.

Therefore, the **H 2.1.2 3** hypothesis was *partially supported*. A significant influence of *gender*, *cancer-effect* and *age* on the *usefulness of personalisation features* was shown, but not of *country* of user's residence (Study 4: $F(4, 108) = .754$, $p = .557$).

7.5 RQ 2.1.3. Do emotions affect cancer website users' behaviour? Do emotions stimulate online health information seeking?

This research question was addressed only in Study 1, by surveying and interviewing target users. Detailed findings are presented in [284]. Overall, the **H 2.1.3 4** hypothesis was *partially supported*. Some *positive emotions* – specifically interest and surprise – *stimulate online health information search*. However, there are also negative emotions – specifically fear and sadness – that influence this user behaviour.

7.6 RQ 2.1.4. Do emotions influence which content and features users will perceive useful, or choose to interact with on a personalised cancer website?

This research question was answered by looking into how *individual positive and negative emotions*, as well as their *aggregated intensities*, influence user perception about the overall *usefulness of website's personalisation*, but also at the level of *individual website features*. The findings are presented in the next five hypotheses.

Correlations for discrete emotions within the same dimension (i.e., shame and embarrassment; disgust and boredom; fear and anxiety) were combined. Results for those emotions (e.g., calmness, awe and excitement) which were not explored in Study 4 and 5 were reviewed. However, they were excluded, as they were not significant or not confirmed by subsequent studies.

7.6.1 H 2.1.4 5a. Overall intensity of pre-use positive emotions positively affects the perceived usefulness of personalisation features.

A significant correlation between *pre-use positive emotions mean intensity* (PEI, without surprise) and the *usefulness of personalisation features* ($\rho = .204$, $n = 110$, $p = .033$) was only found in Study 4. However, Study 4 reliability analysis indicated that the *pre-use positive emotions factor had poor internal consistency, and therefore this finding was not accepted*. Moreover, the results for the remaining three studies showed the two factors were not significantly correlated (e.g., Study 5: $\rho = .084$, $p = .711$), and hence suggest that **H 2.1.4 5a** is *not supported*.

7.6.2 H 2.1.4 5b. Overall intensity of pre-use negative emotions negatively affects the perceived usefulness of personalisation features.

A significant correlation, negative and weak, between *pre-use negative emotions mean intensity* (NEI) and *usefulness of personalisation features* ($r = -0.210$, $p = 0.039$) was only discovered in Study 3, in which the PORT website with generic personalisation was evaluated. Hence, **H 2.1.4 5b** hypothesis is *supported*, however, primarily when referring to the usefulness of generic personalisation.

7.6.3 H 2.1.4 6a. Discrete pre-use positive emotions positively influence how useful each individual personalisation feature is perceived.

Due to multiple comparisons between each discrete emotion and individual personalisation features, Holm-Sidak [324] corrections were applied to the significance level. The initial corrected α was:

- Study 2: $\alpha = 0.05/(24*13) = 0.00016$;
- Study 3: $\alpha = 0.05/(33*12) = 0.000126$;
- Study 4: $\alpha = 0.05/(32*9) = 0.000174$;
- Study 5: $\alpha = .05/(42*9) = 0.000132$.

At the corrected α , no significant correlations were found for the discrete *pre-use positive emotions*. Nevertheless, there were correlations across the four studies that were significant at $\alpha = 0.05$. Moreover, the correlations coincided in multiple studies. The **argument** here is that *relations found at 0.05 or lower significance levels, which coincided in several studies, should be considered significant and preserved in support of the hypothesis*. Appendix M (Section M.1) shows a detailed list of associations for the discrete pre-use positive emotions which were significant at the 0.05 level and at the corrected α . Next outlined are only those *associations which were discovered significant by more than one study*:

- **Interest and User profile customisation** (Study 5: $r = .575$, $p = .04$; $X^2(8) = 17.06$, $p = .029$; Somers' $d = .422$, Gamma = $.628$, $p = .059$; Study 4: $r = .275$, $p = 0.005$) and a related feature - *enabling the user to customise the website by updating their preferences and personal data* (Study 4: $r = .206$, $p = 0.037$).
- **Interest and Bilingual content/selecting language** (Study 5: $r = .817$, $p = .001$; $X^2(8) = 21.67$, $p = .006$; Somers' $d = .563$, Gamma = 1.0 , $p = .001$; Study 4: $\rho = .277$, $p = 0.004$; Study 3: $X^2(16) = 26.39$, $p = 0.049$; Somers' $d = .101$, Gamma = $.143$, $p = .223$).
- **Interest and Adapting text colour** (Study 4: $X^2(16) = 28.86$, $p = 0.025$; Somers' $d = .065$, Gamma = $.092$, $p = .433$; Study 2: $\rho = .248$, $p = .037$).

Thus, in summarising the results, the **H 2.1.4 6a** hypothesis was **partially supported**. At 5% significance level, pre-use *interest* positively influences the perception of *certain individual personalisation features*. *Surprise* was the only emotion with a significant effect (reported in the next section), however a negative one. Therefore surprise was explored as a negative emotion in the later studies (Study 4 and 5).

7.6.4 H 2.1.4 6b. *Discrete pre-use negative emotions negatively influence how useful each individual personalisation feature is perceived.*

The treatment of multiple comparisons was explained in the section addressing **H 2.1.4 6a** (Section 7.6.3). *At the corrected α* , Bivariate correlation tests and Chi-square tests

showed the following **significant associations** between the *discrete pre-use negative emotions* and *usefulness of the individual personalisation features*:

- *Surprise* and *User profile customisation* (Study 3: $X^2(16) = 50.6, p = 0.000018$; Somers' $d = -.186$, Gamma = $-.279, p = .072$; Study 2: $X^2(32) = 46.95, p = .043$; Somers' $d = -.110$, Gamma = $-.139, p = .249$)
- *Surprise* and *Rating content* (Study 4: $X^2(16) = 55.96, p = 0.000002$; Somers' $d = .061$, Gamma = $.09, p = .533$)
- *Surprise* and *Bilingual content* (Study 4: $X^2(16) = 57.04, p = 0.000002$; Somers' $d = .006$, Gamma = $.009, p = .948$)
- *Surprise* and *Information bubbles in profile editing* (Study 3: $X^2(16) = 61.36, p = 0.000000$; Somers' $d = -.144$, Gamma = $-.203, p = .225$)
- *Sadness* and *Search outcomes presentation* (Study 3: $X^2(16) = 55.04, p = 0.000003$; Somers' $d = -.102$, Gamma = $-.179, p = .264$)
- *Anger* and *Rating content* (Study 4: $X^2(16) = 61.01, p = 0.00000003$; Somers' $d = .058$, Gamma = $.086, p = .577$)
- *Anger* and *Bilingual content* (Study 4: $X^2(16) = 57.83, p = 0.000001$; Somers' $d = -.098$, Gamma = $-.140, p = .343$)
- *Anger* and *Giving feedback on the website* (Study 4: $X^2(16) = 48.49, p = 0.000004$; Somers' $d = -.043$, Gamma = $-.059, p = .692$)
- *Disgust* and *Sending private messages to a psychologist* (Study 5: $r = -.968, p = 0.00000416$; $X^2(2) = 10.00, p = .007$; Somers' $d = -1.0$, Gamma = $-1.0, p = .035$)
- *Boredom* (i.e., *disgust*) and *Commenting* (Study 3: $X^2(16) = 52.02, p = 0.000011$; Somers' $d = -.289$, Gamma = $-.451, p = .001$; $\rho = -.344, p = .001$)
- *Embarrassment* (i.e. *shame*) and *Filtering recommended content on user profile page* (Study 3: $\rho = -.421, p = .0000241$; $X^2(16) = 25.03, p = 0.015$; Somers' $d = -.487$, Gamma = $-.729, p = .000$)
- *Fear* (and *anxiety*) and *Filtering search outcomes* (Study 3: $X^2(16) = 54.39, p = 0.000004$; Somers' $d = -.063$, Gamma = $-.092, p = .585$)
- *Fear* (and *anxiety*) and *Search outcomes presentation* (Study 3: $X^2(16) = 57.65, p = 0.000001$; Somers' $d = -.108$, Gamma = $-.177, p = .353$)

Additionally, there were associations with the discrete pre-use negative emotions at the 0.05 significance level. A detailed list is provided in Appendix M (Section M.2). Next outlined are only those associations which coincided in several studies:

- **Surprise** and **Readlist/bookmarks** (*Study 3*: $\rho = -.334$, $p = .001$; *Study 2*: $X^2(32) = 46.52$, $p = .047$; Somers' $d = -.059$, Gamma = $-.084$, $p = .518$)
- **Disgust** (or *Study 3*: *boredom*) and **Adapting text size** (*Study 5*: $X^2(3) = 10.00$, $p = .019$; Somers' $d = 1.0$, Gamma = 1.0 , $p = .236$; *Study 3*: $X^2(16) = 34.04$, $p = 0.005$; Somers' $d = -.307$, Gamma = $-.423$, $p = .000$; $\rho = -.351$, $p = .000419$)
- **Disgust** and **Forum discussions' recommendations** (*Study 5*: $X^2(3) = 15.00$, $p = .002$; Somers' $d = -.714$, Gamma = $-.714$, $p = .285$; *Study 4*: $X^2(16) = 28.87$, $p = 0.025$; Somers' $d = .058$, Gamma = $.078$, $p = .699$)
- **Disgust** (or *Study 3*: *boredom*) and **User profile customisation** (*Study 2*: $\rho = -.258$, $p = .027$; *Study 3*: $X^2(16) = 36.1$, $p = 0.003$; Somers' $d = -.324$, Gamma = $-.485$, $p = .000$; $\rho = -.379$, $p = .0001306$)
- **Sadness** and **Commenting** (*Study 4*: $X^2(16) = 28.17$, $p = 0.03$; Somers' $d = -.031$, Gamma = $-.043$, $p = .726$; *Study 3*: $X^2(16) = 26.45$, $p = 0.048$; Somers' $d = .013$, Gamma = $.021$, $p = .890$)
- **Anger** and **Defining personal interests** (*Study 5*: $\rho = -.545$, $p = .024$; *Study 4*: $\rho = -.206$, $p = 0.039$)
- **Anger** and **Forum discussions' recommendations** (*Study 5*: $X^2(6) = 15.92$, $p = .014$; Somers' $d = -.352$, Gamma = $-.655$, $p = .113$; *Study 4*: $X^2(16) = 32.82$, $p = 0.008$; Somers' $d = -.146$, Gamma = $-.200$, $p = .193$)
- **Anger** and **Sharing content** (*Study 4*: $X^2(16) = 30.34$, $p = 0.016$; Somers' $d = -.132$, Gamma = $-.175$, $p = .258$; *Study 2*: $X^2(36) = 67.1$, $p = .000274$; Somers' $d = .000$, Gamma = $.000$)

All seven of the negative emotions affect how certain features are perceived. However, *negative emotions do not necessarily have a negative influence*. For example, *fear* has a positive impact on how *filtering by cancer type* is perceived, or *shame* positively affects the perception of usefulness of *Emotion Tool's* appearance. Therefore, **H 2.1.4 6b** hypothesis was *partially supported*.

7.6.5 H 2.1.4 7. *Emotions users feel at the start and during website use can predict which content and features they will interact with.*

User activities on the PORT website with emotion-based personalisation (Phase III and IV versions) were logged. Thus, the H 2.1.4 7 hypothesis was tested in Study 4 and Study 5, by applying data mining to the user-interactions data. It was also answered by exploring how long-term users interact with the website, based on the *longitudinal study* data (Appendix K) and *Study 5 interview* data (Appendix J).

7.6.5.1 Study 4: Website interactions

Website logs recorded the content and features participants in the Study 4 experiment visited while interacting with the *Phase III PORT website with emotion-based personalisation* (EXT version: <http://dev.port.org.ba/>). The **dataset** extracted from the website log included only the activities of users who logged into the website and recorded their emotions at login and/or during usage. The **descriptive statistics** of the dataset show, within the sampled website interactions, that users performed *1286 actions*. The dataset contained *74 cases* and the following types of variables:

- Emotions at login
- Emotions reported during usage
- Features interacted with
- Content viewed/read.

The reported emotions were classified into the following two groups. *Emotions at login* (L) were collected only once, immediately after login. *Emotions during website use* (D) were emotions reported either after a content rating or after clicking on the Emotion Tool icon.

There were features and content that none of the users interacted with, potentially because they did not notice them. These features were excluded from the dataset and were not used in generating the prediction models. They included: terms of use, contact psychologist, sharing content, selecting between long and concise privacy policy, orange

triangle notifications icon, and greeting with a username. Moreover, the experiment tasks explicitly asked the users to *select the website language* and use the *Emotion Tool*. Hence, these features were also not analysed, as the users did not choose to interact with them on their own accord, but because they were instructed to do so. Otherwise, the users were able to freely interact with the website, by assuming the role of a person affected by cancer, as explained in Chapter 4 (Section 4.4.3).

The user interactions with the website were mined using *classification* with **10-fold cross-validation**. JRip rules and J48 tree were applied as classifiers, as they enabled rule-based and visual presentation of the results. The **accuracy threshold** set for the selection of rules was **60%**. A class variable was created for each feature and content in the dataset. Class values were:

- None – if there were no interactions (0) with the content/feature;
- One – if only one viewing/interaction was performed;
- More – if the content/feature were clicked/viewed more than once.

Note that the emotion intensity scale in Study 4 ranged from 1 (not at all) to 5 (experiencing the emotion extremely). The rules with 60% or higher accuracy are next outlined:

1. (*Surprise* L ≤ 1) AND (*Shame* L ≤ 1) AND (*Joy* L ≤ 4) ⇒ *Profile – recommendations=One* (12.0/4.0¹³); accuracy 73%
2. (*Shame* L ≤ 1) AND (*Fear* D ≤ 3) ⇒ *Profile - recommendations=One* (11.0/3.0); accuracy 75.7%
3. (*Fear* L ≥ 3) AND (*Sadness* L ≤ 2) AND (*Anger* L ≥ 2) ⇒ *Profile - blog=One* (3.0/0.0); accuracy 91.9%
4. (*Fear* D ≤ 1) ⇒ *Red rectangle in user profile=One* (7.0/3.0); accuracy 70.3%
5. (*Sadness* L ≥ 4) AND (*Anger* L ≤ 1) ⇒ *Edit profile – completing interest data fields=One* (2.0/0.0); accuracy 82.4%
6. (*Surprise* D ≥ 3) AND (*Surprise* L ≥ 2) ⇒ *Forum discussions recommendations on Forum main page=More* (2.0/0.0); accuracy 91.9%

¹³ JRip classifier output: the numbers in the brackets indicate rule coverage, i.e., number of instances (weight) the rule correctly classifies / number of instances misclassified by the rule

7. (*Disgust L* ≥ 2) \Rightarrow *KB recommendations* on KB pages=One (4.0/1.0); accuracy 63.5%
8. (*Surprise D* ≥ 2) \Rightarrow *Articles recommendations* on Articles pages=One (8.0/3.0); accuracy 68.9%
9. (*Interest D* ≥ 4) \Rightarrow *Commenting*=One (4.0/1.0); accuracy 73%
10. (*Joy D* ≥ 2) AND (*Surprise L* ≤ 2) \Rightarrow *Adaptive storyline* content=More (2.0/0.0); accuracy 93.2%
11. (*Sadness D* ≥ 5) \Rightarrow *Categories*=One (3.0/1.0); accuracy 68.9%
12. (*Anger D* ≤ 1) \Rightarrow *Edit Profile*=One (7.0/2.0); accuracy 64.9%
13. (*Surprise L* ≥ 5) \Rightarrow *Forum main page*=One (2.0/0.0); accuracy 75.7%
14. (*Sadness L* ≤ 1) AND (*Fear L* ≥ 3) \Rightarrow *Forum main page*=One (6.0/2.0); accuracy 75.7%
15. (*Surprise L* ≥ 5) \Rightarrow *Blog main page*=One (2.0/0.0); accuracy 83.8%
16. (*Interest D* ≤ 3) \Rightarrow *Search*=More (5.0/1.0); accuracy 82.4%

7.6.5.2 Longitudinal study

Longitudinal data on user interactions with the PORT website with emotion-based personalisation (Phase III version) was also collected within Study 4. The methodology and findings of the longitudinal study are explained in greater detail in Appendix K and Chapter 4 (Section 4.3.3.1). In the course of the longitudinal study, users familiarised themselves with the personalised PORT website by using it over a period of one month. The *findings* obtained from the longitudinal data showed the following correlation:

Interest and Content recommendations on the profile page ($\rho = -.968, p = 0.007$).

It is implied thereby that *repeat visitors*, who experience *interest* at login, are not likely to interact with the *content recommendations* provided on the *user profile* page.

7.6.5.3 Study 5: Interview findings

In *Study 5*, two other **long-term users** (i.e., repeat visitors) of the PORT website have been **interviewed** (see Appendix J for interview procedure). Moreover, the two users were cancer patients, the main target group for this research. I observed and discussed with the interviewees their interaction with the latest version of the PORT website (Phase IV version) when they were in different affective states. The following was discovered:

IF *sadness* at login (L) is of *mild intensity* THEN user views and clicks on *Article recommendations*.

IF *interest* L is *very intense* (intensity 3) THEN user gives feedback to recommendations by responding to *Is this a useful recommendation?*

IF *interest* L is *very intense* AND *joy* L is *very intense* THEN user views and reads *articles-related content*.

These findings and the longitudinal study results were used in support of the prediction rules obtained from user interactions with the latest PORT website. The final set of classification rules obtained for this research is presented in the next section.

7.6.5.4 Study 5: Website interactions

Additionally, in *Study 5* (Experiment 2), 40 first-time visitors interacted with the latest PORT website with emotion-based personalisation (Phase IV version). The participants were instructed to use the website for *5 minutes* assuming the *role of a person affected by cancer*. Experiment 2 design is explained in detail in Chapter 4, Section 4.4.4.

The resulting dataset of user-system interactions had *40 cases* and included the same type of variables as the *Study 4* user-interactions dataset. As in *Study 4*, **two types of emotions** were reported: *emotions at login (L)* and *emotions during website use (D)*. A **class variable** was also created for each feature and content, with values: **None** – no interactions; **One** – one viewing/interaction; **More** – several interactions.

Interactions with the feature *Emotion Tool* were also analysed; however, as participants were instructed to report emotions at login, the use of the tool at login was not counted. All other instances of use of the Emotion Tool – e.g. at rating, counted towards the total number of times a single participant had used this feature within a single website visit.

The same data mining criteria was applied as in Study 4: *classification* (JRip rules and J48 tree algorithms) with *10-fold cross-validation*, and *accuracy threshold* of 60%. The complete list of the discovered classification rules is presented in Appendix N.

One of the Study 5 classification rules (presented at the end of this section) with high accuracy was: *(Interest D >= 3) => User profile=One*. It is particularly interesting as it is in line with the following findings:

- Longitudinal website use data (Section 7.6.5.2): *Interest L* and *Content recommendations on the user profile page* ($\rho = -.968, p = 0.007$);
- Study 5 correlations between discrete pre-use emotions and usefulness of personalisation features (Appendix M): *Interest* and *User profile content* (Study 5: $X^2(8) = 16.49, p = 0.036$);
- Study 3 correlations between discrete pre-use emotions and usefulness of personalisation features (Appendix M): *Interest* and *Content recommendation matched to personal interests* presented on the user profile page (Study 3: $X^2 = 27.23, p = 0.039$).

Some of the rules with accuracy below 60% were taken into account, as they coincided with significant correlations from previous studies. These include:

1. IF *interest* experienced at login is = 4 THEN users click on *Articles and news content* once (accuracy 47.5%);
 - coincided with:
 - Study 5 correlations between discrete pre-use emotions and usefulness of personalisation features (Appendix M): *Interest* and *Articles content* (Study 5: $r = .591, p = .033$);

- Study 4 prediction rule of lower accuracy (not included in the list in Section 7.6.5.1): *Interest L > 3: Articles content=More* (33.31/17.96) (accuracy 40.5%);
 - Study 5 interview findings: *Interest L >= 3 AND Joy L >= 3 THEN Articles content viewed*.
2. IF *disgust* experienced at login is ≥ 2 THEN users click on *Knowledge base content* more times (accuracy 47.5%);
- coincided with:
 - Study 4 prediction rule number 7: (*Disgust L ≥ 2*) \Rightarrow *KB recommendations on KB pages=One*
 - *Disgust* (Study 3: boredom) and *Knowledge base recommendations* (Study 3: $\chi^2 = 25.9, p = 0.011$).
3. IF *joy* experienced at login is ≤ 1 THEN users click on *highlighted features/content* more times (50% accuracy).
- This rule was also considered as it was important from the perspective of emotion-based personalisation, i.e., user interaction with features adapted to their emotions.

It was explained in Chapter 4 (Section 4.3.1.2) that the *emotion intensity scale* was changed on the latest Emotion Tool (Phase IV PORT website). Instead of 1-5, intensity was expressed on a scale from 0 (*not at all*) to 4 (*extremely*). Hence, intensity 1 reported in the Study 4 rules (Section 7.6.5.1) corresponds to intensity 0 in the Study 5 rules (presented below), and so forth.

All the **rules** which were *accepted for Study 5* are next outlined. These findings are discussed in Chapter 8, in line with other results on the effect of pre-use emotions on website personalisation. Particularly interesting rules, which have been supported by several studies, are annotated in bold (e.g., 12, 17 and 18), as follows:

1. (*Surprise L ≤ 0*) \Rightarrow *Language selection=None* (4.0/1.0)

2. (*Interest D* ≥ 4) \Rightarrow *Language selection*=None (3.0/0.0)
3. *Interest L* ≤ 1 : *Language selection*=None (2.0/1.0¹⁴)
4. *Interest L* > 1 AND *Surprise L* ≤ 0 : *Language selection*=None (4.47/1.24)
5. *Interest L* > 1 AND *Surprise L* > 0 : *Language selection*=One (33.53/7.76)
6. (*Sadness D* ≥ 2) \Rightarrow *Notifications bell with orange triangle*=One (2.0/0.0)
7. (*Interest D* ≥ 4) \Rightarrow *Add to readlist*=One (3.0/1.0)
8. (*Disgust D* ≥ 0) \Rightarrow *Emotion Tool*=One (5.0/1.0)
9. *Interest L* ≤ 2 AND *Shame L* ≤ 2 : *Emotion Tool*=None (11.54/3.54)
10. *Interest L* ≤ 2 AND *Shame L* > 2 : *Emotion Tool*=One (3.46)
11. *Interest L* > 2 : *Emotion Tool*=None (25.0/3.0)
12. (***Interest D*** ≥ 3) \Rightarrow ***User profile***=One (4.0/1.0)
13. *Surprise L* ≤ 0 AND *Joy L* ≤ 0 : “*What did you think about the following content?*”=One (2.11/0.11)
14. *Surprise L* ≤ 0 AND *Joy L* > 0 : “*What did you think about the following content?*”=None (2.34)
15. *Surprise L* > 0 : “*What did you think about the following content?*”=None (35.56)
16. (*Interest D* ≥ 4) \Rightarrow *Sorting/filtering profile recommendations*=One (3.0/1.0)
17. (***Interest L*** ≥ 4) \Rightarrow ***Articles and news*** content=One (6.0/1.0)
18. (***Disgust L*** ≥ 2) \Rightarrow ***Knowledge base*** content=More (5.0/1.0)
19. *Joy L* ≤ 1 : Clicking on *highlighted features/content*=More (15.14/9.38)
20. *Joy L* > 1 : Clicking on *highlighted features/content*=None (24.86/6.24)

7.6.5.5 Hypothesis result

Therefore, as Study 4 and Study 5 data produced precise rules with high accuracy, this indicated that *certain discrete emotions users feel at the start and during website use are able to predict which content or features users will choose to interact with*. Hence, **H 2.1.4 7** was *partially supported*.

¹⁴ J48 classifier output: the numbers in the brackets indicate rule coverage

The implications of these findings are discussed in detail in Chapter 8 (Section 8.3.5) and Chapter 9 (Section 9.1.2). They were used to extract a set of rules for *emotion-based adaptation*, which this research confirmed, and hence recommends for implementation on cancer websites.

7.7 RQ 2.2. Do users of personalised cancer websites prefer adaptivity or adaptability?

7.7.1 H 2.2 8. *Users of personalised cancer websites prefer adaptability over adaptivity.*

In Study 3, the *preference for personalisation approach* (PA) was tested. Respondents were classified into two groups, preferring adaptability or adaptivity, as in Equation 8, where i is the number of responses, and a *Response* (see Appendix B for responses) can be 1 (Yes) or 0 (No):

$$PA = \sum_{i=1}^5 \text{Response} = \begin{cases} \geq 3; PA = \text{prefer adaptability} \\ < 3; PA = \text{prefer adaptivity} \end{cases} \quad (8)$$

Chi-square goodness of fit test showed a significant difference in the preferences for approach to personalisation ($\chi^2(1) = 11.8, p = .001$). Fewer users preferred adaptivity (32.7%), while the majority (67.3%) of *people affected by cancer*, who used PORT's website, *preferred adaptability*. Hence, **H 2.2 8** was *supported*; the majority of target users preferred to participate in the customisation of website features and personally provide information about themselves.

7.7.2 H 2.2 9. *Users of personalised cancer websites find adaptability more useful than adaptivity.*

Usefulness of the two personalisation approaches was tested in the last two studies. Target users find both *adaptivity* (Study 4: mean = 3.55, median = 3.67, N = 113, SD = .7; Study 5: mean = 3.93, median = 4, N = 22, SD = .4) and *adaptability* (Study 4: mean

= 3.62, median = 3.8, N = 113, SD = .7; Study 5: mean = 3.89, median = 3.9, N = 19, SD = .45) *significantly useful* according to the one sample Wilcoxon signed rank test ($p < .001$).

Moreover, *adaptability* was found to be significantly more useful than *adaptivity*, based on the Study 4 results for the Wilcoxon signed ranks test (Study 4: $Z = -2.3$, $p = .023$; of 113 cases, 70 had positive ranks). Therefore, **H 2.2 9** is *supported*.

7.7.3 H 2.2 10. *Depending on their background, users differ in their preference for a personalisation approach.*

The user background characteristics which were found to significantly influence how useful the two personalisation approaches are perceived are *gender* and *cancer-effect*. Hence, **H 2.2 10** was *partially supported*.

In Study 4, a significant difference was found between male and female users in how useful they perceive adaptivity ($U = 846.5$, $Z = -3.1$, $p = .002$) as well as adaptability ($U = 853.0$, $Z = -3.1$, $p = .002$). Namely, *female* participants rated the *usefulness* of both *adaptability* (mean rank for females = 61.97 vs. males = 42.19) and *adaptivity* (mean rank for females = 62.06 vs. males = 42.01) higher than male participants.

The Kruskal Wallis H test, applied to Study 4 data, also indicated that the *effect of cancer* significantly influences how useful adaptability ($X^2(4) = 14.3$, $p = .006$) and adaptivity ($X^2(4) = 13.8$, $p = .008$) are perceived. Users whose *friend is a cancer patient* gave the highest usefulness rating for *adaptability* (mean rank = 76.5), followed by *those who do not consider themselves affected by cancer* at all (mean rank = 59.7), then whose *family member is a cancer patient* (57.8). The lowest ratings were given by users who are *only interested in cancer information* (48.5) and finally *cancer patients* (22.1). Similarly, *indirectly affected users* rated the *usefulness of adaptivity* the highest (mean rank for those affected via a friend = 72.5, and via a family member = 58.3), followed by users interested in cancer information (49.8), while adaptivity was perceived the least useful by cancer patients.

7.7.4 H 2.2 11a. Users experiencing negative emotions of high intensity perceive adaptivity useful (they prefer adaptivity).

The *usefulness of adaptivity* is not significantly predicted by the *mean intensity of pre-use negative emotions* (e.g., Study 4: $\rho = -.013$, $n = 107$, $p = .894$). However, the Kruskal-Wallis H test applied to Study 3 data showed a significant difference ($\chi^2(1) = 7.756$, $p = 0.005$) in the *mean intensity of pre-use negative emotions* in those user who *preferred adaptivity* (mean rank 60.88) compared to those who *preferred adaptability* (mean rank 43.98). Logistic regression model further supported the findings ($\chi^2(2) = 8.13$, $p = .017$; Nagelkerke $R^2 = 0.111$, correctly classified 66.3% of the cases). The *preference for a personalisation approach (PA)* can thus be expressed as (Equation 9):

$$PA = 1.112 - 0.864 * NEI + 0.470 * PEI \quad (9)$$

Overall, **H 2.2 11a** was *partially supported*, in terms of users' perceived preference for a personalisation approach, but not based on user experience with such services. Hence, negative emotions lead users to believe they would rather delegate the control to the system, i.e., be offered adaptivity.

7.7.5 H 2.2 11b. Users experiencing positive emotions of high intensity perceive adaptability useful (they prefer adaptability).

It is the opposite case in this hypothesis. *Pre-use positive emotions mean intensity (PEI)* does not significantly predict a *preference for adaptability* ($\chi^2(2) = 8.13$, $p = .017$; Equation 9, for PEI $p > .05$). However, PEI does significantly positively influence the *usefulness of adaptability* based on Study 4 and 5 results (e.g., Study 5: $r = .467$, $n = 19$, $p = .044$). Therefore, **H 2.2 11b** is *supported*.

7.8 RQ 2.3. Which factors determine user satisfaction with website personalisation?

7.8.1 H 2.3 12. *Majority of users express satisfaction with cancer website personalisation.*

Descriptive statistics and one sample inferential tests suggest that users were on average *satisfied with the website offering generic personalisation* (Study 3: mean = 3.9, SD = 0.63; one-sample Wilcoxon signed rank test, $p < 0.05$), as well as *satisfied with the website with emotion-based personalisation* (Study 4: mean = 3.5, SD = 0.6; $t(112) = 9.11, p = .000$). **H 2.3 12** is thus *supported*.

7.8.2 H 2.3 13. *If users perceive cancer website personalisation features as useful, they will also be satisfied with the website's personalisation.*

The perceived *usefulness of personalisation features* and the *satisfaction with the personalisation* were significantly positively correlated (Study 4: $\rho = 0.28, p = 0.003$). The results thus *support* the **H 2.3 13** hypothesis – that useful website personalisation leads to user satisfaction.

7.9 RQ 2.4. Which factors influence how usable the website is perceived?

7.9.1 H 2.4 14. *Background characteristics influence how usable users perceive a personalised cancer website.*

Study 4 data indicated that *country of residence* is associated with the perception about *usability*. According to the Mann-Whitney U test results ($U = 941.5, Z = -2.44, p = .015$), *participants from B&H scored usability significantly higher* than participants from *other surveyed countries* (B&H mean rank = 67.8, other countries mean rank = 51.6). Moreover, Study 3 results show a significant association between *age* and *usability* ($r = .250, p = .013$).

Therefore, **H 2.4 14** is *partially supported*. There is a potential effect of *age* on the perceived usability of the *website with generic personalisation*, as well as an effect of *where the user lives* on how usable they perceive the *website with emotion-based personalisation*.

7.9.2 H 2.4 15. The more useful cancer website personalisation features are perceived, the higher the website usability.

Correlation tests showed that the more *useful personalisation features* were perceived, the significantly more *usable* the website was considered (Study 4: $\rho = 0.223$, $n = 112$, $p = 0.018$; Study 3: $\rho = 0.545$, $n = 97$, $p = 0.000$). Overall, **H 2.4 15** hypothesis is *supported*.

7.10 RQ 2.5. Does interaction with a personalised cancer website affect user emotions?

The four studies of this research show that the most intensely experienced emotions at the start of cancer website use are positive emotions: *interest* (above moderate), *calmness* (approximately moderate), *joy* (above mild), *excitement* (around mild intensity). The intensity of post-use emotions followed a similar trend. However, several negative emotions were also felt; these are: *sadness* (mean intensity slightly above mild), surprise (around mild), boredom (around mild). Generally, in studies that use self-reporting instruments to measure emotions, rarely reported are high and extreme intensities [151].

7.10.1 H 2.5 16a. Negative emotions post-use have lower intensity than negative emotions pre-use.

The Wilcoxon signed rank test for two related samples was applied to the discrete emotions experienced before and after website use. The results indicated a significant change in the intensity of the following negative emotions:

- *Sadness decreased* and increased (decreased in Study 4: $Z = -2.0$, $p = .045$; median remained at 2, mean rank pre-use 27.88 decreased to 25.83 post-use; while it *increased* in Study 2: $Z = -3.117$, $p = .002$; median increased from 1 to 2).
- *Fear increased* (Study 4: $Z = -4.51$, $p = .000$; median increased from 1 to 2; and Study 2: $Z = -2.74$, $p = .006$).
- *Surprise increased* (Study 4: $Z = -3.52$, $p = .000$; median increased from 1 to 2, mean rank pre-use 21.43 increased to 27.73 post-use; and Study 3: $Z = -3.81$, $p = 0.000$, median increased from 1 to 2).
- *Anger increased* (Study 4: $Z = -2.53$, $p = .012$; median remained at 1, mean rank pre-use 21.21 increased to 21.62 post-use).

Moreover, Study 4 data showed that the overall *mean intensity of negative emotions significantly differed* between the two stages of website use ($Z = -4.5$, $p = .000$), whereby the intensity of negative emotions was higher after using the website. **H 2.5 16a** was thus *not supported*.

However, the intensity of certain discrete negative emotions – fear, surprise and anger – did change significantly, by increasing post-use. Only the intensity of *sadness* decreased in one of the studies; however the results of the other study contradict this finding and indicate that sadness too increased.

7.10.2 H 2.5 16b. *Positive emotions post-use have higher intensity than positive emotions pre-use.*

A Wilcoxon signed rank test indicated that the use of the personalised cancer website resulted in a significant change in the intensity of:

- *Joy/Happiness decreased* (Study 4: $Z = -2.2$, $p = .027$, median remained at 1, mean rank pre-use 19.18 decreased to 14.42 post-use; Study 3: $Z = -2.72$, $p = 0.007$, median decreased from 3 to 2; Study 2: $Z = -2.937$, $p = .003$, median decreased from 4 to 3);

- *Interest decreased* (Study 4: $Z = -2.51$, $p = .012$; median increased from 3 to 4, while mean rank pre-use 26.19 decreased to 25.91 post-use).

Therefore, **H 2.5 16b** is *not supported*. Nevertheless, as with the previous hypothesis, the intensities of positive emotions did change significantly by decreasing post-use.

7.10.3 H 2.5 17a. *The greater the satisfaction with website personalisation, the less intensely are negative emotions experienced after website use.*

Satisfaction with website personalisation was not significantly correlated with the *post-use negative emotions mean intensity* (Study 4: $p > 0.05$; Study 3: $F(1, 94) = 2.4$, $p = 0.125$). However, Study 3 indicated this factor influences some of the discrete post-use negative emotions, for example - *surprise* ($\rho = .269$, $n = 96$, $p = .008$) and *boredom* ($\rho = -.383$, $n = 96$, $p = .000$). **H 2.5 17a** was thus only *partially supported* - for boredom, while it significantly affects surprise, however positively.

7.10.4 H 2.5 17b. *The greater the satisfaction with website personalisation, the more intensely are positive emotions experienced after website use.*

Based on Study 3 results, *satisfaction with website personalisation* can significantly predict the *mean intensity of positive emotions* ($F(1, 94) = 17.1$, $p = 0.000$; $R = .392$, adjusted $R^2 = .145$). A unit increase in the former factor increases the dependent factor by 0.437 units, when holding all other independent variables constant.

Moreover, Study 3 indicated a significant positive correlation between the *satisfaction* factor and *interest* ($\rho = .419$, $n = 96$, $p = 0.000$) and *excitement* ($\rho = .370$, $n = 96$, $p = 0.000$), as well as a potential positive correlation with *awe* ($\rho = .206$, $n = 96$, $p = 0.044$). Therefore, **H 2.5 17b** is *supported*.

7.10.5 H 2.5 18a. Users who do not perceive the website as usable will experience high intensity of negative emotions post website use.

Study 3 findings showed a *significant negative* correlation between *usability* and the *mean intensity of negative emotions* ($\rho = -.308$, $n = 98$, $p = .002$). Moreover, when testing the influence of usability on each discrete post-use emotion, the associations at the corrected α were found for: *shame* (Study 4: $\rho = -.338$, $n = 106$, $p = .000$) and *disgust* (Study 4: $\rho = -.274$, $n = 106$, $p = .004$). At 0.05 level, usability was negatively associated with anger (Study 4: $\rho = -.196$, $n = 106$, $p = .044$) and fear/anxiety (Study 3: $\rho = -.204$, $n = 98$, $p = .017$), and positively with sadness (Study 4: $\rho = .206$, $n = 107$, $p = .033$).

Therefore, **H 2.5 18a** hypothesis is **supported**. The more usable the website is perceived, the less intense are negative emotions, particularly *shame*, *disgust* and, possibly, *anger* and *fear*. Sadness contradicts the hypothesis, as an *increase in the perceived usability increases sadness*, however this finding was not significant at the corrected α .

7.10.6 H 2.5 18b. Users who perceive the website as usable will experience positive emotions in high intensity post website use.

Study 3 findings also indicated a *significant positive* correlation between *usability* and the *mean intensity of post-use positive emotions* ($\rho = .324$, $n = 98$, $p = .001$). The influence of usability on discrete post-use emotions at the corrected α was seen only for *interest* (Study 4: $\rho = .199$, $n = 109$, $p = .038$; Study 3: $\rho = .452$, $n = 98$, $p = .000003$), and potentially *joy* at 0.05 significance level (Study 3: $\rho = .293$, $n = 98$, $p = .003$).

H 2.5 18b is thus **supported**. Usability increases the intensity of post-use positive emotions; it particularly intensifies *interest*.

7.10.7 H 2.5 19a. Perceived usefulness of adaptability or adaptivity increases the intensity of post-use positive emotions.

Usefulness of both personalisation approaches – adaptivity ($\rho = .275$, $n = 111$, $p = .004$) and adaptability ($\rho = .225$, $n = 111$, $p = .018$) - significantly increases the *mean*

intensity of post-use positive emotions. However, as explained in Section 7.2.2, the latter factor in Study 4 did not have sufficient internal consistency. Therefore, the effect of the two factors was tested on the discrete positive emotions.

Usefulness of both *adaptive* ($\rho = .314$, $n = 110$, $p = .001$) and *adaptable* ($\rho = .276$, $n = 110$, $p = .003$) website services intensifies post-use *interest*. Hence, **H 2.5 19a** is *partially supported*, with respect to the significant effect on interest.

7.10.8 H 2.5 19b. Perceived usefulness of adaptivity or adaptability decreases the intensity of post-use negative emotions.

The findings show only a potential positive effect of *usefulness of adaptivity* on the emotion *surprise* ($\rho = .202$, $n = 107$, $p = .037$), at the 0.05 significance level. Nevertheless, as the results were not significant; **H 2.5 19b** was *not supported*.

7.11 RQ 2.6. Which factors determine reuse intentions for a personalised cancer website?

Finally, emotions evoked by using a personalised cancer website, satisfaction with the personalised services, and usability of such a website, were tested for their effect on user intentions to reuse the website. The following five hypotheses answer this research question.

7.11.1 H 2.6 20. People affected by cancer intend to reuse a personalised cancer website.

The hypothesis **H 2.6 20** was *supported*. Users agreed (e.g., Study 4: mean = 3.7, SD = 0.71; $t(112) = 9.93$, $p = .000$) that they wanted to *reuse the website with generic and emotion-based personalisation*.

7.11.2 H 2.6 21. Satisfaction with cancer website personalisation and intentions to reuse the website are positively associated.

Satisfaction with website personalisation significantly positively affected *reuse intentions* (Study 4 linear regression model: $F(1, 111) = 128.5, p = .000$; Beta = .732; $t = 11.33, p = .000$). The results **support H 2.6 21**.

7.11.3 H 2.6 22. Usability of a personalised cancer website and intentions to reuse the website are positively associated.

Correlation tests indicated a significant positive relationship between the perceived *usability* of and *intentions to reuse* the personalised website (Study 4: $\rho = .45, n = 112, p = .000$; Study 3: $\rho = .45, n = 98, p = .000$). Thus, **H 2.6 22** hypothesis is **supported**. The more usable users perceive the websites with both generic and emotion-based personalisation, *the higher the reuse intentions*.

7.11.4 H 2.6 23a. The higher the intensity of post-use positive emotions, the higher the website reuse intentions.

A significant positive correlation was discovered between the *post-use positive emotions mean intensity* and *reuse intentions* (Study 3: $\rho = .411, p = .000$). The effect of *discrete post-use positive emotions* was further tested. This finding is interesting and relevant, since post-use emotions are those that potentially result from interacting with the website and, thus, are assumed to determine more likely how a user feels about reusing the website.

Multiple regression was applied; the model was significant (Study 4: $F(9, 97) = 2.65, p = .009$; $R^2 = .123, R = .445$). The significant correlations for the discrete positive emotions (results coinciding in several studies are presented in bold) at the corrected α were:

- **interest** (Study 4: $\rho = .2, p = .036$; Study 3: $\rho = .500, p = .000$)
- **excitement** (Study 3: $\rho = .397, p = .000$; Study 2: Beta = -0.4, $p = 0.004$)

- *awe*, potentially at 0.05 significance level (Study 3: $\rho = .219, p = 0.03$).

Overall, **H 2.6 23a** is **supported**. If the *intensity of positive emotions is high*, particularly if experiencing *interest* (and potentially excitement and awe), *reuse intentions increase*.

7.11.5 H 2.6 23b. **The lower the intensity of post-use negative emotions, the higher the website reuse intentions.**

According to Study 4 data, *post-use negative emotions' mean intensity* was associated with *reuse intentions* ($\rho = .199, n = 111, p = .036$), moreover, *positively*. I further tested whether the *discrete post-use negative emotions* influence reuse intentions. Multiple regression was applied in Study 4, as presented for the previous hypothesis. The relationship can be represented by Equation 10, as follows:

$$\begin{aligned} \text{RI} = & 2.83 + 0.012 * \text{Fear} + 0.218 * \text{Interest} + 0.16 * \text{Sadness} - 0.135 * \\ & \text{Surprise} + 0.099 * \text{Guilt} - 0.024 * \text{Joy} - 0.063 * \text{Shame} - 0.122 * \text{Anger} + \\ & 0.107 * \text{Disgust} \end{aligned} \quad (10)$$

Correlation tests were also used, with corrections for multiple comparisons. The significant associations (results coinciding in several studies are presented in bold) for the discrete negative emotions were:

- ***sadness*** (Study 4: $\rho = .28, p = .003$; Study 3: $\rho = .231, p = 0.022$)
- ***fear*** (Study 4: $\rho = .22, p = .019$; Study 3: $\rho = .280, p = .000$)
- *surprise* (Study 3: $\rho = .400, p = .000$)
- *boredom* (Study 3: $\rho = -.397, p = .000$)
- *guilt* (Study 2: regression model - Beta = 0.39, $p = 0.012$).

Overall, **H 2.6 23b** is **not supported** for the nine emotions this research last considered. Only *boredom*, which was not part of the last set of discrete emotions, was shown to significantly *decrease* reuse intentions. Nevertheless, certain *discrete post-use negative emotions* do *significantly positively* influence reuse intentions. Experiencing negative

emotions intensely, and particularly *fear*, *sadness*, *guilt* and *surprise*, significantly *increases website reuse intentions*.

7.12 RQ 2 Summary

The main discussion of the findings for RQ 2 is provided in Chapter 8. This section provides a brief overview of the findings.

Personalisation, generic and emotion-based, is generally perceived as useful for a cancer website. Certain background characteristics – such as gender and cancer-effect - influence user perception about personalisation. Specific discrete pre-use emotions appear to influence user perception of and use of website features and content. Website interaction data implies that all emotions, apart from guilt, have an impact on which features and content users choose to use.

Users prefer adaptability, however find both approaches to personalisation useful. The perception about either of the two personalisation approaches is not significantly affected by user background.

Positive perception about the usefulness of website's personalisation features increases user satisfaction and improves the perceived usability of the website. The use of and perception about a personalised website reflect unexpectedly on post-use emotions - positive emotions decrease, while negative emotions mainly increase. Moreover, satisfaction with personalisation and usefulness of adaptivity or adaptability mainly influence positive emotions. While website usability decreases the intensity of negative emotions – shame and disgust; or intensifies interest.

Post-use emotions, satisfaction with personalisation and website usability, all stimulate the reuse of a personalised cancer website. Interestingly, both positive and negative emotions increase reuse intentions. A more comprehensive discussion of the findings presented here is the main topic of the next chapter.

Chapter 8

Discussion

Chapter 8 discusses the research findings reported in the previous two chapters. This chapter addresses and elaborates the two main contributions (Chapter 2, Section 2.7.2) of this research - the *conceptual framework for exploring the influence of emotions on personalisation and intentions to reuse a personalised cancer website*, and *establishing user preferences for emotion-based personalisation and adaptation on these websites*.

8.1 What is the state of the art in online cancer information seeking? (RQ 1.1)

In the five studies performed, this research *sampled a variety of populations* to establish **who the people affected by cancer are**, and whether and **why they use online cancer resources**. The sampled populations were from more than a dozen countries worldwide, including: B&H, US, UK and Jordan, as well as Turkey, Serbia, Netherlands, Malaysia, Germany, Italy, Slovakia, Slovenia, Switzerland, China, Croatia, Portugal and Poland, and a few other infrequently represented. The majority of the sampled people belonged to the 25-36 age group, and were slightly more represented by females than males. In fact, previous statistics show that the largest percentage of health information seekers on the Internet are younger users [11, 61], and women [22, 63, 64].

The sampled people were mainly *indirectly affected by cancer*, through family members suffering from this disease. However, an almost equal proportion did not have experience with cancer, but were interested in cancer information, for prevention or awareness-raising purposes. This reflects the real-life context of the effect of cancer; it is not only the person suffering from cancer who is fighting this disease, but also a large number of family members or friends. It is, hence, often the caregivers who go online to search for cancer information for their family member or a friend who is suffering from cancer. Thus, *it is also necessary to tailor online services to those indirectly affected by cancer*.

8.2 Personalisation for cancer websites

This section discusses the findings related to whether introducing personalisation to a cancer website, particularly emotion-based personalisation, is what target users prefer.

8.2.1 *Adoption of personalisation on Web-based health services (RQ 1.2)*

The results here showed that *the full potential of personalisation has not been explored* on health websites *in either B&H or the UK*. Certain level of personalisation is available, however is not based on user profiling. Specifically, the lacking and neglected features relate to personalised content and adaptation. Adaptive navigation and presentation features have been, almost as a rule, overlooked. Thus, advanced features lacked on B&H and UK websites.

Importantly, it is not the amount of information that makes online health services usable, but being able to quickly find the content reflecting the needs, preferences and other user characteristics. This is best achieved by introducing comprehensive personalisation services. To explore the type and level of personalisation desired by cancer website users, the ***PORT personalised cancer website*** was developed for this research. Personalisation was adopted gradually, in four implementation phases, to enable comparison of different levels of personalisation.

8.2.2 *Do people affected by cancer prefer to have emotion-based personalisation, generic personalisation, or no personalisation on a cancer website? (RQ 1)*

In exploring user preferences for the desired level of personalisation, target users engaged with and evaluated the different versions of the PORT cancer website. Generally, the *personalised website versions were rated with higher usability scores*. Moreover, a *higher proportion of users preferred the website with emotion-based personalisation*.

The findings did imply that *the difference in the usability of the cancer websites without personalisation, with generic personalisation and with emotion-based personalisation,*

was *not significant*. Furthermore, the *preference* for *emotion-based personalisation* over generic personalisation was *not significant*. However, it is important to discuss the factors that potentially affected the obtained results. Consequently, it should be also considered whether to rely exclusively on inferential test results.

It is likely that people presently fighting cancer – directly or indirectly – will find greater relevance in using a (personalised) cancer website, and invest more time in engaging with it, than someone who has experienced cancer in the past or someone briefly seeking for general prevention information. Study 5 interviewees, as representatives of current and former cancer patients, point toward this conclusion. However, given the limited resources, a large proportion of the participants in this research were indirectly affected by cancer, in the past. Moreover, they were first time users, unfamiliar with the website.

Furthermore, the controlled *experiments* - lengthy surveys and short website usage time – could have also had an impact on the results. Firstly, it is possible that participants' attention span was reduced during the demanding experiments. Secondly, participants stated they believed they *needed to have a longer exposure to the PORT website* and 'real-world' use (potentially suggesting using the website when actually in need of and searching for cancer information). Users of the latest version of the PORT website claimed they liked the emotion-based recommendations, however that in the provided usage time, they were unable to notice the changes in the recommendations or feature adaptation. This research hence suggests that *forming preferences for a level of personalisation requires longer exposure to personalised services*.

Based on the points made above, the significance of inferential statistics offers *limited explanation*. They only reflect the *context* of first time users, who had a very limited website usage time, were exposed to several versions of the website (with the same design and content) at the same time, who were most likely not previously exposed to emotion-reporting on online services, and potentially were not personally vested in the cancer topic. Therefore, relying entirely on whether the difference between the levels of personalisation was significant, offers a narrow view. In these circumstances, it is arguably *worth looking into descriptive statistics* obtained for the different website

versions across the several studies. Moreover, it is necessary to *review user comments from the surveys and interviews* to delve deeper into user attitude toward personalisation on a cancer website.

The results of the four studies of this research suggest that the *more advanced personalisation* the website offers the *higher its usability score*. The *non-personalised cancer website* had the *lowest usability score* in all the three studies it was evaluated in. Interestingly and importantly, the website with ***emotion-based personalisation*** had the ***highest usability scores*** in both of the studies it was evaluated and was *more frequently preferred*. The percentage of users who considered this website usable was higher than the percentage of those who evaluated generic personalisation or no personalisation as usable. Moreover, in Study 4, which had the largest number of participants, the *PORT website with emotion-based personalisation* was the only website version that was rated with an ***above average SUS usability score***. The findings for RQ 2 (Chapter 7, Section 7.3) furthermore showed that the *personalisation features* on the PORT website with emotion-based personalisation were considered *useful*.

An interesting finding, though not statistically significant, was related to the *level of personalisation found more usable in different affective states*. In line with the broaden-and-build theory [201], in a *positively valenced aggregated affective state* users like to explore and engage in new activities, therefore they rated the personalised website versions, particularly the *emotion-based personalisation*, with the highest usability. In *neutral states*, users are not incentivised to additional activities, but rather narrowly focus on what they came to the website for. Therefore, they find more usable the website *without personalisation*. It would be expected that *negative emotions* further reduce user incentive for involvement. However, interestingly, in a negatively valenced aggregated affective state, users considered the personalised websites, particularly *generic personalisation*, as more usable.

Interview findings, furthermore, shed light on ***preferences for personalisation by users familiar with the website***. According to these users, the *website without personalisation* is a better choice for a *one-time or infrequent visitor* who came to the website to *search*

for *a specific cancer topic*. Importantly, ***long-time users*** (repeat visitors) *prefer* a cancer website with *personalisation*, and *more so* the one with ***emotion-based personalisation***.

Interviewees clearly expressed a preference for *emotion-based adaptation*. The fact that the changes in presentation of content and features were noticed and liked, *suggest an agreement with the adaptation received*. Moreover, interviewees unambiguously favoured *receiving content recommendations*. This type of users considers the main *drawback of non-personalised websites* their *inability to guide towards relevant content*. However, interviewees also explained that their *first time exposure* to the PORT website, as an uncommon online service that asked them to report emotions, caused a level of *apprehension toward emotion-based content recommendations*. During the first visits to the website, they *feared their interests and content preferences might be neglected in favour of emotions*.

However, the interview findings show that longer exposure to the website enables users to become aware of how emotions affect the changes in content recommendations and appearance of the website. Consequently, *repeat website visitors become familiar* with emotion-based personalisation, and thereafter claim they *enjoy having the additional options* and *prefer emotion-based personalisation* on a cancer website.

8.3 Do emotions influence the perception about personalisation and intentions to reuse a personalised cancer website? (RQ 2)

The following sections discuss the findings for RQ 2, reflecting on the research model relations. Specifically, I discuss the effect of emotions on how users perceive website personalisation, whether interaction with a personalised website induces emotions, and whether these factors influence user decision to revisit a cancer website. Moreover, the personalisation features particularly preferred by cancer website users are elaborated on. The hypotheses results of the five studies are summarised in Appendix H.

8.3.1 *Personalisation features and personalisation approach users would like to have on cancer websites (RQ 1.2, RQ 2.1.1 and RQ 2.2)*

The findings of the first study of this research suggested that cancer website users are interested in receiving personalisation; however, that the websites are lagging in the adoption of these services. People affected by cancer would specifically like to have *personalisation features related to content*, as well as those enabling control over how personal information is used. The features target users considered not favourable for a cancer website were, e.g., *disabling links*, and *personalised ads*, showing their concern for missing out on information, and their rejection of advertising.

The desired features were *implemented on the PORT website*, as well as expanded and refined based on user evaluations. Hence, in interacting with the personalised cancer website developed for this research, target users had a chance to experience different types of personalisation (more than 30 types of personalisation features). It was thus possible to establish actual user preference for specific personalisation features, as well as personalisation approaches.

Evaluations of the PORT website confirm that *users perceive that personalisation on a cancer website is useful*. Furthermore, users prefer to participate in customising the website, in providing feedback about website services, in defining their interests; overall, having a certain level of control. Given the type of data collected on a cancer website, anxiety is reasonable, as well as users' potential desire to have control over what personal data is disclosed. While users *prefer adaptability*, they also consider *adaptive services useful*. This conforms to studies in other areas [84, 326], such as e-learning [84], that suggest either a semi-adaptive or adaptable approach. The majority of Internet users prefer to have control over content personalisation, and having control is a key factor of personalisation acceptance [95]. Thus, *on cancer websites, adaptivity and adaptability should co-exist and complement each other*.

8.3.1.1 Do users perceive personalisation features introduced to a cancer website as useful? (RQ 2.1.1)

Usefulness of personalisation was further evaluated *at the level of individual features*. The *majority of personalisation features* and functionalities users were offered on the PORT website were *rated useful or very useful*. The *bottom ranked features* were generally not considered useless, but rather *users were indifferent about their availability* on a cancer website.

8.3.1.1.1 Bottom ranked features

Users were mainly *neutral* about receiving *personalised notifications*, both on the website – e.g. reminders to complete their profile data or to rate content they read, and via e-mail. It could be that notifications, which generally appear automatically and do not disappear until the user responds to them, were considered a nuisance or even spamming.

Further indifference was shown toward *forum-related content*, including its *recommendations*. Interview findings suggest that cancer website users, especially in the initial stages of information research, have a greater preference for knowledge base articles and news. However, interviews also suggest that forum and blogs might be of interest in later stages of battling with cancer, in establishing contact or learning about other people's experience with cancer. Moreover, given that feature evaluations in this research were based on user experience with the PORT website, it could be that the expressed indifference was not towards the usefulness of having forum content, but rather that the forum content on the PORT website was not perceived sufficiently useful. This assumption is reasonable, as currently the least amount of content is available within the website's forum.

Indifference was also expressed for the *personalised greeting*. This could indicate a preference for anonymity, i.e., avoiding an invasion of privacy. However, as interview findings imply, it is more likely that this feature is not seen as relevant in searching for cancer-related information. Nevertheless, interview reports also show that users do not necessarily dislike being greeted with their name. In fact, they are relatively used to this

feature from other online services and find it establishing a level of closeness or personal ownership. Interestingly, in Study 4, which evaluated the PORT website with emotion-based personalisation, this feature was rated one of the top useful features.

Similarly, neutral opinions prevailed about the usefulness of *adapting text colour*. This is contradicted by interview findings, which show that, for a revisiting user affected by cancer, this feature is very useful, particularly for those having sight problems. Moreover, users who spend a long time at a computer screen or are bothered by viewing highly contrasting colours (black letters on white background) appreciate having the option to adjust the text colour. It is likely that the majority of survey participants, who belonged to the 25-36 age group, did not exhibit sight problems and therefore could not relate to the use of this feature.

Interview findings provide a similar explanation for *tailoring website background colour*. Reducing the contrast of website colours, or being able to personalise website background, is considered by some as useful. Surveys showed users were mainly indifferent about tailoring the background colour. Moreover, it was the only feature rated as not useful in one of the earlier studies. Nevertheless, tailoring website background on that version of the PORT website was not yet fully developed, as it was based only on selecting an image for the background. In later phases, users could choose a favourite colour for adaptive adjustment, or they could explicitly choose a background colour.

A common trend can be extracted from the above-presented findings. Cancer website users are not particularly keen on features that give them a sense of urgency or irritation. They perceive more useful content-related features than additional services. Nevertheless, they appreciate a variety of features, as well as content, as long as it is left to them to choose whether to use the feature or not.

8.3.1.1.2 Top ranked useful features

Essentially, *cancer website users find it useful to have a variety of personalisation services*. The *features* that were found the **most useful for cancer websites** are next discussed.

Content recommendations are highly popular with cancer website users. Such are, for example, *adaptive storyline* guiding to additional similar content, or recommendations of article (news) and knowledge base content, i.e., more factual information. Data on user interaction with the PORT website showed that *article* and *knowledge base content recommendations* were extensively viewed. Interview findings further show that users like to first explore knowledge base and articles related content. It is not surprising that content recommendations were among the top useful features throughout this research. After all, cancer websites are primarily visited to find relevant cancer content.

Interestingly, however, user interactions with the latest version of the PORT website showed that users mainly *did not click on content recommendations on their profile pages* or on *adaptive storyline* recommendations. Nevertheless, this finding has to be interpreted with care. The experiment (Study 5, Experiment 2) assigned only five minutes for website usage and it did not instruct which services to visit.

It is possible that some of the users *did not notice the link to their profile page*, and thereby did not see the recommendations on that page. Others that visited the profile page could have been *distracted by other features displayed before the list of recommendations*. This is likely, as the profile page first presents to new users notifications to complete their data – i.e. red rectangle (which was clicked on a few times) – and thereafter, the latest website content. Hence, users might not have been inclined to scroll further down the page and thus did not notice the list of content recommendations.

Nevertheless, website interaction data also shows that the filter for recommendations was clicked on several times. Depending on the emotions they reported, some users were likely to notice the title Recommendations and the filter for recommendations. These were users whose emotions (e.g., if intensity of surprise > 1; see Appendix F) triggered hiding certain website features, including the red rectangle notifications on the profile page. However, other users reported emotions which did not result in hiding the red rectangle notifications. They were thus possibly distracted by responding to this feature,

which led them to another page, and hence altogether might not have seen the recommendations on the profile page.

Interviewees, who used the PORT website more frequently, on the other hand, claimed they would scroll through the profile page and liked receiving and viewing the content recommendations there. Moreover, users frequently clicked on recommendations displayed on other highly visible website pages, e.g., article and knowledge base. Thus, it is not for the *dislike of the recommendations that users did not click on them, but most likely the inability to notice them, as they were new users.*

Similarly, *adaptive storyline* - which opens at the bottom of the screen - was not frequently clicked on. First time users would not have been aware that their actions could result in additional content being presented. Longitudinal study showed that content recommended within the *adaptive storyline was viewed and clicked on.* Moreover, in Study 5 (Experiment 1), users who were instructed to interact with this feature and explore its functionality gave it a high usefulness score.

Study 5 interview findings further indicate that *the features and content a user will choose to interact with might depend on familiarity with the website and purpose of the visit.* Hence, at the **first visit** to the website, particularly if searching for information *for someone else*, a user would look for factual content. Thereby, the user would visit and read **Knowledge base content**, **filter** content **by cancer type**, and also *likely* view **Articles**. After becoming **more familiar** with the website, particularly if searching for information for oneself, a user would specifically go to their **profile page**, as well as other parts of the website (e.g., top of the main page of Articles) displaying **content recommendations**. Users would view content recommendations after some number of visits to the website, as they would then be *expecting the website to have gathered sufficient information about their content preferences, interests and emotions, to be able to give them relevant recommendations.*

Importantly, *users desire content recommendations*, moreover they perceive the *recommendations offered on the PORT website as useful.* One of the most useful features was *enabling users to feedback on whether or not they liked the individual content*

recommendations. Website interaction data indicates that the feature “**Is this a useful recommendation for you?**” was among the most frequently used. For the predominant part, users rated the recommendations provided on the PORT website as useful. Thereby *users explicitly expressed they liked the content recommendations inferred from their interests, content preferences, as well as emotions*, as was explained to them on the latest PORT website version.

Website interaction data, interestingly, shows that users explored and **edited their personal data**. Even though user profile customisation was not among the top useful features, users nevertheless devoted time to edit their profiles. *Repeat website visitors*, according to the longitudinal study, particularly *frequently customised their profile data*. Moreover, the findings also show that being able to **define personal interests** for cancer content was considered one of the most useful features. According to the interview findings, being able to *define the type of cancers and cancer information of interest*, is *the most important service to repeat visitors* of the website. Interviewees claimed the foundation of *all content offerings on a cancer website should primarily be based on understanding and matching user interests*.

Another highly useful and very frequently used feature on the PORT website was **content rating**. As with defining interests and giving feedback about recommendations, the assumption is that *rating content enables users to express their preferences*. Moreover, content reviews and ratings are common features on the real-world online services, thereby there is a level of familiarity with this feature and its benefits.

The ability to **filter content** was also considered highly useful. Search was also among the most frequently used features. Interestingly, interviewees also highly praised the availability of filters by cancer type. As with search and filtering, *content categorisation* was considered very useful, since it enables easier overview of available content, and thus faster and easier access to the desired content.

8.3.1.2 Emotion-based features (RQ 2.1.1)

Emotion-based features on the PORT website were all perceived *useful*, even though they were not necessarily rated the most useful features. The emotion-based features that will be discussed in this section particularly refer to: content recommendations on user profile page and article and knowledge base pages; Emotion Tool; explanation why a recommendation was given; and emotion-based highlighting adaptation.

As explained earlier, *content recommendations* on the PORT website with emotion-based personalisation were *rated as useful*. The findings indicate that *repeat visitors favour receiving emotion-based recommendations*. However, *first time exposure* to an online service that requires reporting emotions and provides emotion-based personalisation, likely *evokes fear* in a user and misconception that their interests and content preferences would be neglected in place of emotions. Thus also that the amount and variety of information presented to them would be restricted.

Thus, in *introducing emotion-based personalisation to a cancer website*, it would be fruitful for providers to *invest in raising user awareness about the services* – how to use the feature and what improvements the feature brings. This could be achieved through user guides, notifications and informative messages, such as the one introduced on the PORT website – “**Why recommended?**” In fact, the findings here show that users consider it *highly useful* when given an *explanation about how their emotions are used in generating content recommendations*. They become *more aware of why they are asked to report emotions and the benefits of this activity*.

Interestingly, user opinions about the **Emotion Tool** and its use on a cancer website are not straightforward. The *availability of the Emotion Tool and its appearance* were rated *highly useful*, even though user comments in Study 4 implied the tool was *complex for expressing sentiment*. Indeed, the Emotion Tool on the earlier version of the PORT website (Phase III version) incorporated the *nine emotions* studied here and the *three dimensions of the SAM instrument*. Reporting emotions on two different instruments added to the level of complexity. Study 5 participants claimed the latest Emotion Tool was slightly boring and that it has too many emotions to report on. Other research has

pointed out that it might be difficult for *individuals to reflect on their affective state* [54]. Nevertheless, as reported in Chapter 2, emotion self-reporting methods, with similar intensity scales and similar number of emotions/moods, were previously used in the related research (e.g., [151]).

Interview findings of my research, in fact, suggest that the *latest Emotion Tool is easy to use*. Interviewees claim the preference for design (e.g. colour choice and emoticons) depends on the individual user. However, they claim the *instrument itself is intuitive, easy to understand and use* for anyone who had experience with any kind of surveying. An additional advantage, according to these repeat visitors, is that it is users' choice whether to report their emotions or close the Emotion Tool.

Nevertheless, interviewees also believe *the tool and reporting emotions require some time to become accustomed to*. The findings suggest that users were neutral about ***reporting their emotions on a cancer website***. User comments, however, indicate *frustration* with the Emotion Tool *appearing automatically at every content rating* and a preference for a button they could click on when desired. Nevertheless, Study 5 interviewees suggested *it is likely they would not remember to use the Emotion Tool*, that the current automatic appearance reminds them to report emotions, and as long as they are offered a chance to close the Emotion Tool, *they prefer the current functionality*.

Furthermore, interview findings offer an explanation why (first time) users might not be interested in reporting emotions. Repeat users claimed, *during the first few visits to the website*, they were slightly *irritated by the tool appearing automatically*, primarily because of the association with pop-ups. However, *once the users grows accustomed to the Emotion Tool*, once they are aware why emotions are collected and see the results in content and feature adaptation, the use of the tool is seen as an *integral part of interacting with a cancer website offering emotion-based personalisation*. Hence, *one of the main issues is the lack of familiarity with the feature*. Current, frequently used, online services do not offer such features. Therefore, the lack of experience causes an initial rejection of the use of the emotion reporting instrument.

Another highly useful emotion-based feature was **adaptation** by *highlighting* and *hiding*. Website usage data showed that *among the most interacted with features were those that were highlighted as a result of expressed emotions*.

Interestingly, the *colour choice for the highlighting* adaptation affected user opinion about the service offered. In Study 4, dark purple background was used for highlighting website links. Interviews show that users did not favour this colour choice; possibly as the main colour on PORT website is purple, hence a darker tone of the same colour made users perceive the link was already clicked on, or did not urge them to further action. However, users were very pleased with the *green colour* used for highlighting *on the latest PORT website*. Interviewees in Study 5 claimed green is a good contrast to other website colours, and a pleasant colour choice, which fits well with the website design.

In the adaptive hypermedia literature, *adaptation is considered efficient if not noticed by users*. The features that were most prominently adapted to user emotions – either highlighted or hidden - such as selecting the language, profile page, adding content to readlist, rating content, were all perceived highly useful by the target users. It can thus be interpreted that highlighted features did not overburden users, and the hidden features were not experienced as a lack of functionality. Thereby, the findings suggest that *emotion-based adaptation was efficiently introduced to the PORT cancer website*.

In summary, cancer website users are primarily interested in content, and the features that enable them to reach the content that matches their needs. Most of the mentioned features, and particularly *content recommendations* (articles and knowledge base), are examples of an advanced level of personalisation. They require gathering significant amount of data about a user (their interests, content preferences, emotions), as well as the use of advanced recommender algorithms. While users might not understand or notice the adaptive navigation, and might not initially be accustomed to reporting emotions, they are intrigued by the prospects of being further guided to the content relevant to them.

8.3.2 *Effect of background characteristics on user perception of website personalisation*

8.3.2.1 *Effect on usefulness of personalisation features, adaptivity and adaptability (RQ 2.1.2 and RQ 2.2)*

This research showed that the *effect of user demographic characteristics* on the *usefulness of personalisation* is only partial. Only *gender* and *how cancer affected users* significantly influenced the perception of *personalisation features*, and the view of *adaptive* versus *adaptable* website services.

Cancer-effect. Cancer patients who are repeat website visitors are likely to prefer emotion-based personalisation to generic or no personalisation. However, the findings also suggest that *cancer patients* are *more critical* in evaluating the usefulness of personalisation services, than users whose *friend is suffering from cancer*. This is reasonable, given that cancer patients directly feel the effects of cancer, and thus have greater needs and expectations from the type of information and services offered on a cancer website. In comparison, users who are not personally experiencing the full impact of cancer might not be as invested in the topic. They might view using the cancer website as any other online resource, and therefore might be more lenient or less interested in the website's personalisation features, including its adaptive and adaptable services.

Gender. The findings indicate that *male* users are stricter in evaluating the usefulness of personalisation. Women are generally more inclined to using online services for health information [63, 64]. As less frequent users, males might be more apprehensive toward any type of features and content they encounter on cancer websites. They might also be more willing to challenge new features, even if it means being critical.

Age. One of my studies also indicated that *age* potentially has an effect; *as age increases* (within the range of 18-57), *personalisation features are viewed more useful*. This is somewhat surprising, as I expected older users to more reluctant about personalisation, and technology in general. The findings could be attributed to younger users', particularly adolescents', higher awareness of technological innovations, due to which they are more demanding and critical of the website's personalisation services.

Fortunately, age and gender have been successfully adopted in user modelling for online personalisation [33, 327-329]. Additionally, the three mentioned user background characteristic can easily be measured.

8.3.2.2 Effect on usability (RQ 2.4)

Usability of a personalised cancer website appears to be affected by the *country* a user is from and *age*. Here too, *younger users* seem stricter and less likely to appraise the website as usable.

An interesting finding is the one linking user *country of residence* to website usability. *B&H users tended to rate the PORT website more usable than users from other countries*. Indeed, the PORT cancer website is intended primarily as support for Bosnian cancer-affected population backed by a Bosnian cancer association. Therefore, the majority of website content was provided in Bosnian language. User comments reveal that participants from other countries claimed the website lacked enough content in English. Moreover, selecting website language/having bilingual content was rated as one of the most useful features. Considering cancer website users' focus on content, it is possible that all the above said could have had a positive impact on B&H users in rating PORT's usability, or a negative effect on users from other countries.

8.3.3 Do emotions affect cancer website users' behaviour? (RQ 2.1.3)

Emotions shape actions and behaviour of human beings, and hence also determine our behaviour in relation to online services. According to the findings of this research, certain *discrete emotions* – specifically *fear*, *interest*, *sadness* and *surprise* - *stimulate online cancer information seeking*. Interviews with cancer-affected people revealed that, upon learning they or their loved one has cancer, people experience fear, and surprise, of what is still the disease with one of the highest mortality rates. *Fear* and *sadness* thereafter lead people to seek cancer-related information, triggering *surprise* and *interest* in finding out about treatments, other's experience or alternative diagnosis. This research showed that the same four emotions - *fear*, *interest*, *sadness*, *surprise* - *stimulate cancer website reuse*

and influence the perception about the usefulness of personalisation features, as discussed in the next sections.

8.3.4 Effect of emotions on cancer website personalisation

8.3.4.1 Effect on usefulness of personalisation features (RQ 2.1.4)

The findings suggest that the *mean intensity of pre-use positive emotions* does not significantly influence the perception of *usefulness of personalisation features*. A possible negative and weak effect of the *mean intensity of negative emotions* was discovered, in one of the studies, specifically on the *usefulness of generic personalisation*.

It is, thus, implied here that *users' impression of the website's personalisation is not precisely determined by the valence of their aggregated affective state*. It is likely that emotions of the same valence can have opposite effects. Thus, aggregating emotions based on their valence does not provide a complete picture of how emotions reflect on user perception of cancer website personalisation services. Therefore and importantly, this research indicates the *need to explore the effects of discrete emotions*.

8.3.4.2 Effect on usefulness of adaptive and adaptable services (RQ 2.2)

Interestingly, however, when website features are classified into *adaptive* and *adaptable*, emotions of the same valence appear to have a common and significant effect. The findings imply that the *intensity of pre-use negative emotions* determines a *preference for adaptivity*, while the *intensity of pre-use positive emotions* influences the *usefulness of both adaptivity and adaptability*. However, the findings have to be interpreted with care.

The factor *preference for adaptability or adaptivity* only measured users' perceived preference for a personalisation approach, without their prior experience with such services. In expressing their perceived preference, users experiencing intense ***negative emotions*** lean toward *adaptivity*. When under the effect of negative emotions, users possibly believe they would rather have the system perform all the customisation and

assume the control, instead of being involved in experimenting with the system [201]. After actually using the PORT website, the negative emotions did not jointly influence how useful users found the two personalisation approaches.

The results, therefore, imply that experiencing *negative emotions only reflects on users' state of mind*, their preconceptions of what services they would like. The joint effect of negative emotions is *defused and becomes insignificant when users have the chance to experience the service first hand*, and, based on that, form an opinion about its usefulness.

Interestingly, the findings indicate that users experiencing ***positive emotions intensely*** at the start of website use might not have a *preference for either adaptivity or adaptability*. However, positive emotions jointly improve user perception of *usefulness of the adaptable* features they had interacted with on the website. Thus, importantly, *positive emotions improve users' view of the features which require additional involvement*. This is in line with the theory of positive emotions [201] - these emotions broaden awareness and entice people to more actions. My research thus extends the theory to the field of personalised cancer websites, and shows that users experiencing intense positive emotions have increased tendencies to interact with, i.e. tailor and explore, the website and its features.

8.3.5 Do emotions influence which content and features users will perceive useful, or choose to interact with, on a personalised cancer website? (RQ 2.1.4)

This research further implies that ***discrete emotions predict the features users prefer and hence rather use on the website***. This section explains the effect of discrete negative and positive emotions.

8.3.5.1 Patterns discovered in the effect of discrete emotions

This research indicates it is difficult to interpret and define the direction of the effect of discrete emotions. Most commonly ***positive emotions*** – specifically interest, appear to

have a **positive effect** on the usefulness of individual personalisation features, while the **negative emotions**, for the majority part, have a **negative effect**.

As positive emotions are known to broaden awareness [201], it is likely they result in openness towards new website features. Users experiencing positive emotions intensely are more likely to explore the website, hence also be more likely to notice that the features and content have been personalised to their needs, and therefore be more likely to perceive the usefulness of such features. Negative emotions cause focusing on the 'centre' of the visual field [201]. For cancer website users, the central focus is the website content, i.e., cancer information, and potentially the prominent website characteristics such as its design and colours. Negative emotions would thus likely decrease user ability in noticing the personalised services – which are uncommon, unexpected features, which usually require user engagement and additional exploration of the website.

However, *this pattern cannot be generalised to all emotions of the same valence, or for all personalisation features. **Discrete emotions**, irrespective of their valence, **can both stimulate interaction with a feature or discourage its use***. For example, an increase in the intensity of sadness increases the frequency of use of website notifications. On the other hand, users are more likely to visit their profile page, if sadness is not felt.

Moreover, the findings here indicate that an *emotion might have a significant effect on a personalisation feature*, however that the **correlation might not be linear** – an increase in its intensity does not necessarily translate into a decrease or increase of usefulness of the personalisation feature. Furthermore, *use of a feature is not only determined by a single discrete emotion, but in certain cases by a **joint effect of several discrete emotions***. Emotions which were most commonly identified in a joint effect (in the opposite or same direction) include: *surprise* with a positive emotion – either *joy* or *interest*; *sadness* with another negative emotion, e.g. – *anger* or *fear*; *shame* with another negative emotion, e.g. – *surprise* or *fear*, or with the positive emotion *interest*.

Finally, *it is not only the **emotions experienced at login**, but also those **evoked during website use that drive user actions and behaviour on a personalised cancer website***. For example, surprise at login and joy during use, affect the interaction with adaptive

storyline. Nevertheless, *interaction a specific feature or content is more likely predicted by **emotions at login** than during website use.*

8.3.5.2 *Positive emotions*

Next discussed is *the effect of the positive emotions – interest and joy*. Previous research suggests that positive emotions lead to a positive experience with the system [54].; e.g., excitement and smiling (i.e., joy) stimulate engagement with website content [174]. My findings also indicate that *interest* - a positive emotion - positively influences the perception of personalisation features. However, the findings also show that positive emotions do not always have a positive effect.

Pre-use **interest** significantly influences the *usefulness of a few personalisation features*, specifically: *customising user profile data, adapting text font, and selecting the website language*. All three features are adaptable services, which supports the finding that positive emotions positively influence the usefulness of adaptability. Therefore, experiencing *interest* is indicative of a positive attitude toward exploring and tailoring the website. *In interacting with the website*, interest experienced at login or during-use predicts the use of a larger number of website features and content types, including: selecting the website's language; commenting on content; searching for content, specifically articles and news; visiting the user profile page and filtering the presented recommendations; creating a readlist; and using the Emotion Tool. All the identified features require user engagement, whereby they can be classified as adaptable services. While interest generally stimulates interaction with website features, users are more likely to use the *search, Emotion Tool* and view *content recommendations*, if interest is less intense or not felt at all. Moreover, intense interest decreases the likelihood of selecting language and using the Emotion Tool.

Individually, **joy** *only predicts interaction with the adapted (highlighted) features*. Interestingly, more joyful users are less inclined to click on the highlighted features, while the less joyful users would rather be guided to the features or content best reflecting their needs. Moreover, in all other cases, *joy affects the use of website features*

in combination with other emotions, particularly surprise. Hence, when a certain intensity of joy (pre- or during-use) matches a certain intensity of surprise, they jointly stimulate or discourage interaction with the following features: content recommendations on the profile page, recommendations offered via adaptive storyline, and being reminded to rate content. It appears that for a joyful user, it is important not to experience surprise, in order to choose to use these features, which are likely unexpected on a cancer website and surprising themselves.

8.3.5.3 *Negative emotions*

Negative emotions affect a larger number of personalisation features, and interestingly in both a *positive* and *negative* way. **Surprise** has a ***negative*** effect on the usefulness of: creating a *readlist*, editing user profile data and being informed why the data is collected. Thereby, being surprised negatively reflects on the perception about features which require users to provide personal information and customise the website, and which stimulate future website visits. Surprised users appear not to favour features which require engagement, bring privacy into question, and thereby potentially cause additional surprise.

On the other hand, *surprise* ***improves*** user opinion about having *bilingual content*, it also *stimulates* the use of features which enable adjusting the *website language*. Surprise *improves the perception of rating content*, however, *discourages* the use of the feature that enables *subsequent content rating*. Interestingly, *surprised* users appear to like *viewing articles* and *forum recommendations*, as well as reading about other people's experience from forum discussions and blogs.

Anger significantly ***negatively*** reflects on the usefulness of *defining personal interests*. In interacting with the website, *anger* also *discourages* the user from visiting the *edit profile page* and completing *interests-related data*. Potentially, users who visit the website in an angry state do not appreciate being asked about their interests, or they cannot be bothered to engage in a laborious activity of specifying four categories of cancer-related interests. On the other hand, experiencing *low intensity* or *no anger at all*, *improves* the perception

of the usefulness of: recommendations of forum content and reviewing the usefulness of a recommendation, sharing content with others, and adjusting website language.

Interestingly, while they do not like to give feedback about recommendations, it appears that angry users find it useful to *review content by rating* it. The rating feature was **positively** affected by both anger and surprise. This reflects the real-life situations when anger leads to discussions, and opinionated expressions, where some form of outlet is desired. Therefore, angry users should be recommended features that enable them a level of control, but features which require participation should be hidden from them.

Disgust significantly **decreases** the perceived usefulness of leaving *comments* on the website or engaging in *communication with (messaging) a psychologist*. Both features entail stating personal opinions or feelings about a cancer-related topic, either publicly (comments) or privately (private messages to a mental health professional). It could also be that a disgusted or bored user finds the functionality of these features, as they are currently provided on the PORT website, tasteless for a cancer website. This could particularly be the case for the latter feature – contacting a psychologist. Users were aware that the feature was in the development stage; PORT has not yet employed a mental health professional to communicate with the website users.

Other features disgust likely influences users to think of as less useful are: adjusting the text font size (as do surprise and anger), and being asked to customise the website and personal profile (as does surprise). Disgusted users potentially perceive these features as irrelevant for a cancer website, or boring and tedious. As with anger, when *disgust* is *extremely intense*, *recommendations of forum content* are *not perceived as useful*. Hence, angry and disgusted users likely do not desire to share their experience or read about other people's cancer-related opinions.

Moreover, users **experiencing disgust** at the start of website use **like** to visit and read more **factual content** in the Knowledge base, including the recommended content. Interestingly, users who *experience disgust during website use* are **eager** to express their emotions by using the *Emotion Tool* - potentially seeking website response that might improve their affective state.

Sadness at different stages of website use has a different effect on similar features. *At the start of website use*, if users *experience little or no sadness*, they are likely to see *usefulness in commenting the website content*, as well as having different options for the *presentation of search results*. However, *experiencing sadness during website use* stimulates the use of features that provide information overview – such as *content categories* - as well as reacting to the *notifications to complete user profile data* and *define cancer-related interests*.

Fearful states also *reduce* the perceived usefulness of *filtering* and *search related functions*. On the other hand, this and previous research show that *fear* stimulates online search for cancer information. Moreover, *notifications to complete the profile data*, which sadness affects positively, are *more likely responded to when less fear is felt during website use*. Notifications potentially cause confusion and additional fear. Users might perceive their private information is not transparently used or perceive a loss of control.

My research showed that *fear* frequently *worked in connection with sadness, however in opposite direction*. For example, *fear* and *sadness* mutually influence visiting *forum- and blogs-related content*; however the use is more likely with more intense fear and less intense sadness. Interestingly, *fear encourages* viewing *user generated content* – blogs and forum discussions - however, *reduces the perception about its usefulness*. Presumably, fearful users like to read about other people's personal experiences with cancer, however, due to fear, they dislike sharing their own opinions or stories. Moreover, fearful users might be anxious about features which require a significant engagement. Hence, it might not be that they dislike the content, but rather involvement from their side.

Shame, as disgust, *stimulates the use of the Emotion Tool*. Similarly to fear, *shame negatively* affects the opinion about the usefulness of *filtering tools*, specifically used for profile recommendations. Moreover, viewing the *content recommended on the user profile page* is *more likely* with *less intense shame*. A possible explanation is that shame inhibits users from going to their profile which presents content specifically reflecting their needs and characteristics. Therefore, recommendations on the profile page could be

perceived as very private, and hence in the state of shame rather not viewed, particularly if it is possible they will be seen by others.

To conclude, *emotions play a role in the behaviour of cancer-affected people*, who *appreciate specific types of personalisation*. Importantly for website providers, this research showed that *emotions can be used to predict the features and content a user would prefer to have recommended*, and *those features they would rather not have to interact with* while using the website. The implications stemming from the emotion-feature relations discussed here are expressed as rules for emotion-based personalisation in Chapter 9 (Section 9.1.2).

8.3.6 How personalisation reflects on satisfaction with (RQ 2.3) and usability of a cancer website (RQ 2.4)

My findings show that people affected by cancer *perceive the personalisation they interacted with on a cancer website as useful and usable*, and are *satisfied* with it.

The majority of users of the personalised cancer website found its features useful. Useful features assist the user in achieving the aim of the website visit, thereby evoking a high level of user satisfaction. While the correlation between the perceived *usefulness of personalisation features* and how *satisfied* a user is with the cancer website's personalisation seems obvious, the fact that the findings confirmed the assumed relationship indicated that participants' responses appeared sensible, rather than random. Hence, it can be inferred that the overall approach used in this research offered reliable findings.

Furthermore, the findings indicate that the *websites with generic and emotion-based personalisation were considered usable*. Moreover, *usefulness of website's personalisation* improves its *usability*. This implies that a website with useful personalisation features is easier to learn to use, is considered consistent and integrated, and thus, provides a high level of usability. Interestingly, however, previous research indicated the opposite – that customisation introduces complexity in system functionality,

and therefore, has a negative effect on usability [243]. Nevertheless, my research implies that *personalisation which is perceived useful, will have a positive effect on how usable a cancer website is perceived.*

8.3.7 Does interaction with a personalised cancer website affect user emotions? (RQ 2.5)

8.3.7.1 Changes in emotion intensities

Moshfeghi and Jose [149] indicated, in their study on emotion recognition in online search activities, that the affective state of a user changes from the beginning to the end of the search process. According to my findings, a *change in the intensity of emotions* also occurs in the process of using a personalised cancer website. However, unlike the hypothesised, the *intensity of negative emotions increased*, whereas the *intensity of positive emotions decreased*.

The intensity of *positive emotions* **joy** and **interest** (as well as excitement and calmness) *decreased* between the two stages of website use. This may have been a foreseeable outcome, as the cancer-related content provided on the website is serious and sobering.

The intensity of **fear**, **anger**, **surprise** and **sadness** *increased*. *Cancer-related information potentially intensifies fear and sadness*. However, when using the website with *emotion-based personalisation*, **sadness decreased**. Potentially, tailoring and adapting to emotions appeased users, as they were guided to content and features they were more likely to prefer when feeling sad. Interestingly, the level of **surprise** *increased*. Given that experiments explained the type of website they would evaluate, users expected to interact with cancer-related content. Hence, the increase in surprise more likely resulted from the services they were not expecting to find on a cancer website, e.g., personalisation and the Emotion Tool.

Clarifications of these findings were obtained by interviewing cancer patients and survivors, who are long-term users of the PORT website. They imply that people might find it difficult to identify emotions they are experiencing, or fear providing such

information. People might further be less inclined to reveal their true emotions when they feel negatively, and hence vulnerably. In fact, this research has shown that both at the start and after website use, negative emotions were on average reported with low intensities or as not felt at all. However, their intensity tended to increase post-use. As the cancer topic is generally serious and likely to cause negative emotions, it is possible that at the end of website use negative emotions were more easily identifiable, and therefore more easily reported on.

The concept known in psychology as the “negativity bias” [330] should also be considered. Negative events grab attention more than the positive do [330], it is an innate mechanism developed for survival [330]. Hence, even a smallest dissatisfaction or annoyance with the website services – e.g., inability to register or login, lack of content in the desired language, having to report emotions frequently – or participation in an experiment itself, could have reflected on the increase of user negativity, and decrease of positivity.

8.3.7.2 Factors affecting post-use emotions

Next discussed are the *factors that induce emotions after website use*. Previous research also showed that emotion can be induced as a result of interaction with online services. Ethier et al. [151] indicated that interaction with an online shopping website induced emotions such as liking, joy, pride, dislike, frustration and fear. Moshfeghi and Jose [149] showed that satisfaction results from successful search activities, while unsuccessful search evokes anxiety or anger. The factors that were explored in this thesis are: satisfaction with personalisation, usability, usefulness of adaptivity and usefulness of adaptability.

How **useful** either **adaptive** or **adaptable** website services are perceived was not found to significantly reflect on the mean intensity of either negative or positive emotions post-use. Ethier et al. [151] also showed that being in control or being able to predict what happens next, when using an e-shopping website, did not significantly influence either positive emotions, such as joy, or negative emotions, such as dislike. Potentially, user

perception of personalisation approaches does not affect emotions of the same valence in the same way. This argument particularly stands, as my research showed that the *perception of the two approaches evokes or intensifies post-use interest*. Moreover, perceiving the *usefulness of adaptive services*, to some extent, *intensifies post-use surprise*.

Satisfaction with website personalisation positively influences *positive emotions*. As long as users are provided the services that satisfy them, specifically personalisation that will ease and improve their website experience, users will become more positive, and particularly more *interested*, after using a personalised cancer website.

However, satisfaction does not influence how negatively a user feels after using the website. That also means, importantly, that *dissatisfaction with the personalisation will not significantly increase negative emotions' intensity*. It can be argued that satisfaction does not reflect the same on all negative emotions, hence exploring them only in an aggregated state will not provide a comprehensive understanding. This argument is supported by the findings that *satisfaction negatively affects post-use boredom*, but it *reflects positively on post-use surprise*.

Usability negatively reflects on the *overall intensity of negative emotions*, however it affects *discrete negative emotions* differently. When the website is perceived as usable, the intensity of emotions such as *shame* and *disgust*, and potentially *anger* and *fear*, reduces after website use. A usable website easily guides users to achieve desired goals, and hence raises users' cancer awareness. Thereby, a usable website should decrease shame in users who might have felt uninformed about cancer. Moreover, usability would decrease disgust and anger, which were potentially evoked by being instructed to interact with a cancer website (in a research experiment), and a user was not personally interested in this type of information. Website usability could also decrease anger and disgust in people affected by cancer who are in the denial or anger stage of grief. Furthermore, a *usable website* appears to achieve its purpose in raising cancer awareness, and thereby likely *increases sadness*.

Interestingly, *usability* of a personalised cancer website has the broadest effect on post-use emotions. It potentially intensifies joy. Importantly, usability *increases* the *overall intensity of positive emotions*, particularly by evoking or intensifying *interest*. It is likely that a usable website induces interest for further website content and revisits.

Similar to the findings in this thesis, Ethier et al. [151] reported that evaluating an online shopping experience positively increases the intensity of positive emotions, specifically liking (similar to interest in this thesis) and joy. Moreover, Pappas et al. [53] found that personalisation in online shopping positively affects positive emotions. These two papers coincide with the findings in this thesis that *satisfaction with personalisation, usefulness of the two personalisation approaches and website usability intensify positive emotions, specifically interest*.

On the other hand, Ethier et al. [151] have indicated that a favourable online shopping experience decreases the intensity of certain negative emotions, specifically dislike (similar to disgust in my thesis) and frustration (anger in my thesis), however it did not significantly influence the intensity of fear. Research by Pappas et al. [53] suggests that personalisation does not significantly influence negative emotions. The latter work coincides with my findings that *usefulness of the two personalisation approaches and satisfaction with personalisation do not significantly influence post-use negative emotions mean intensity*. However, the former paper better coincides with my findings for the usability of a personalised website. Whereby, *website usability primarily reflects on negative emotions*. Most of the negative emotions (shame, disgust, potentially fear and anger) are negatively affect by usability, apart from the likely positive effect on sadness. The overall *implications are that providing personalisation is beneficial, as it reduces negative emotions, and increases the intensity in positive emotions*.

8.3.8 Which factors determine reuse intentions for a personalised cancer website? (RQ 2.6)

After interacting with a personalised cancer website, people affected by cancer *intend to reuse* it. There are several factors that influence these behavioural intentions.

8.3.8.1 *Effect of usability and satisfaction*

People affected by cancer are more *likely to subsequently use* a personalised cancer website when they find it *usable*, and when they are *satisfied with* its personalisation. This finding coincides with the research by Pappas et al. [53], who report that personalisation positively influences purchase intentions in online shopping. Reasonably, users who feel that the website matched their needs, will be satisfied with the personalisation, and will perceive the website as usable. Consequently, they will have higher intentions to reuse the personalised website. This finding implies that *adopting personalisation positively affects behavioural intentions to reuse cancer websites*.

8.3.8.2 *Effect of post-use emotions*

My results further showed that emotions experienced after website use influence whether users want to revisit the website. Previous research also indicated the effect of emotions on behavioural intentions on online services. Anxiety and enjoyment were shown to influence IT use and acceptance [168-171].

As presumed, the *overall intensity of post-use positive emotions increases* the likelihood of *reuse intentions*. This finding coincides with Pappas et al. [53], who report that positive emotions positively influence purchase intentions in online shopping. They further suggest that negative emotions also significantly negatively affect purchase intentions [53]. Lu et al. [175] also found that negative – specifically anger, feeling upset and feeling irritated - negatively influence repurchase intentions. My findings suggest that the *mean intensity of post-use negative emotions* potentially *increases* reuse intentions. However, that it is actually the discrete negative emotions that significantly influence reuse intentions, and in different ways. Moreover, contrary to other researchers' findings, most of the *negative emotions* studied in this thesis *positively reflect on user intentions*. However, the context and domain of the research have to be accounted for; while they explored an online shopping website and purchase intentions, this thesis researched a cancer website and reuse intentions.

Hence, this research implies that *reuse intentions* are *positively affected* by **discrete positive and negative emotions**. The positive impact of emotions of different valence was also seen in a study by Berger [141] who indicated that content capable of inducing both positive and negative emotions of high arousal levels would also be more frequently shared.

Interest (as well as *excitement*) as expected, has a *positive effect on reuse intentions*. More interested users are more willing to revisit the website. This is in line with findings in online gaming research [331]. Previous research also reports that enjoyment influences the use of the Web [172], and stimulates intentions to revisit a website [176]. However, interestingly, my research did not find the effect of *joy* to be significant.

Unlike the expected, the majority of the **negative emotions** also *positively affect reuse intentions*. While some previous research showed a negative relation between negative emotions and online behavioural intentions [53, 125], others show the impact can be positive [141]. The influence of negative emotions is thus not straightforward.

Sadness and **fear** both increase reuse intentions. Increased fear or sadness can lead to website revisits, in order to, e.g., learn more about cancer and hence either be in a better position to fight it, if one (or a close one) is already affected, or to prevent it, if not. Moreover, previous studies [64] and interviews with people affected by cancer which I conducted, show that *interest* and *surprise*, but also *fear*, *stimulate online health information search*.

Based on my findings, **surprise** and **guilt** also potentially increase reuse intentions. It is assumed that users were positively surprised by the website's services – particularly personalisation services, they might not have encountered on other cancer websites. Hence, their surprise increased the desire to visit and explore the personalised website again.

One discrete *negative emotion* found to have a **negative effect** was *post-use boredom*. This finding coincides with research suggesting that negative emotions negatively influence online purchase intentions [53, 125]. It is not surprising that *boredom* reduces

the desire to revisit the website. Moreover, boredom could have been evoked by the conditions of the research experiments and been transferred to the website.

Overall, the goal should thus be to *maximise certain positive and negative affects to increase reuse intentions for personalised cancer websites*. Therefore, it is not the valence of emotions that is important in determining reuse intentions, but rather inducing specific discrete emotions, such as *interest, sadness, fear* and potentially *surprise*. These emotions can be evoked in the process of cancer website use by providing users with factual cancer information, by attending to the usability of the website and user satisfaction with the personalised services.

8.4 Summary

This chapter provided a comprehensive discussion of the research findings. Each research question was individually addressed. The first part of the chapter discussed the findings for RQ 1. These suggested that target users – people affected by cancer who are return website visitors - are inclined to emotion-based personalisation on cancer websites.

The second part of the chapter addressed the results for the conceptual framework relations (RQ 2). These were discussed in connection to the findings of previous research. Moreover, potential reasons for why some of the hypotheses were not supported, and why contradicting results were reached in other cases, were elaborated.

The next chapter concludes this thesis. It highlights the theoretical and practical implications stemming from the research findings. Thereafter, it overviews the limitations, future research areas and draws a conclusion.

Chapter 9

Conclusion

Chapter 9 is the concluding chapter of this thesis. The *first part* presents *theoretical and practical implications* of my research. Theoretical implications are drawn from the discovered framework relations (RObj4; Chapter 1, Table 1.1). Practical implications are devised in the form of the personalisation and adaptation rules (RObj7; Chapter 1, Table 1.1) this research has confirmed. The *second part* of the chapter gives an overview of the research *limitations* and identifies potential directions for the *future research*. Finally, a *conclusion* is made about the research presented in this thesis.

9.1 Research implications

9.1.1 Theoretical implications: revised framework

Theoretically, this research *explored the role of emotions in predicting the preference for personalisation features, as well as their effect on user's behavioural intentions for personalised cancer websites*. Figure 9.1 presents the final model of dependencies between factors affecting reuse intentions for personalised cancer websites. Hence, while the related theories: show causes of emotions and the effect of emotions on human behaviour; have researched system acceptance factors, such as usefulness, usability and satisfaction, in certain contexts; and implied the role of social exchange on evoking an emotional response - this research extends the theories and makes several contributions.

The ***first research proposition*** (RP1, the first group of theories, Chapter 3, Section 3.2.1.1) was confirmed. *User background influences the perception of website's personalisation*, as follows. Male users and cancer patients are more critical of the usefulness of personalisation features, while female users and those indirectly affected by cancer are more likely to give higher usefulness ratings. Nevertheless, there are other user traits that play a role in this process. *Emotions* users come to the cancer website with *affect how they perceive the personalisation features* offered on the website. However, a

common effect of emotions of the same valence was not evident. In fact, it appears that discrete emotions have a unique impact.

Positive emotions do seem to work jointly toward improving how useful personalisation is perceived. Nevertheless, the effect of *interest* prevails, and its influence is unambiguously positive, however only on a few features – e.g., text adaptation and editing profile. *Negative emotions* influence a larger number of personalisation features; however, they do not work in the same direction. *Fear, sadness, shame* and *disgust* reduce the *usefulness* of individual personalisation features. *Surprise* and *anger* mainly have a negative impact. Interestingly, they *affect some features positively*; specifically they improve the perception about selecting website language and rating content. Moreover, emotions influence the perception of adaptivity and adaptability, in different ways. *Negative emotions* entice people to believe they would *prefer adaptivity* on a cancer website. *Positive emotions*, on the other hand, stimulate users to find the *adaptable website services* they interacted with as *useful*.

With respect to the ***second proposition*** (RP2, the second group of theories, Chapter 3, Section 3.2.1.2), this research showed that users generally perceive that *personalisation* on a cancer website *is useful*. This reflects positively on user *satisfaction with personalisation* and website *usability*. Nevertheless, cancer website usability is also determined by users' age and their country of origin.

These factors - *satisfaction with website personalisation, usefulness of adaptivity and adaptability* and *website usability*, in turn, evoke *post-use emotions*. They have a common effect - all four factors *intensify* or evoke *interest*. *Usefulness of adaptive and adaptable* features principally intensifies positive emotions. *Satisfaction with personalisation* has a positive effect on all positive emotions; and only potentially negatively influences the negative emotion *disgust*. *Surprise* is likely intensified by *satisfaction*, as well as the *usefulness of personalisation* (particularly *adaptive services*). *Usability* has a more encompassing effect, on both positive and negative emotions. It *evokes interest*, and to some extent *joy*. Importantly, it *decreases* the intensity of *shame* and *disgust*, also likely of *anger* and *fear*; however, it potentially *intensifies sadness*.

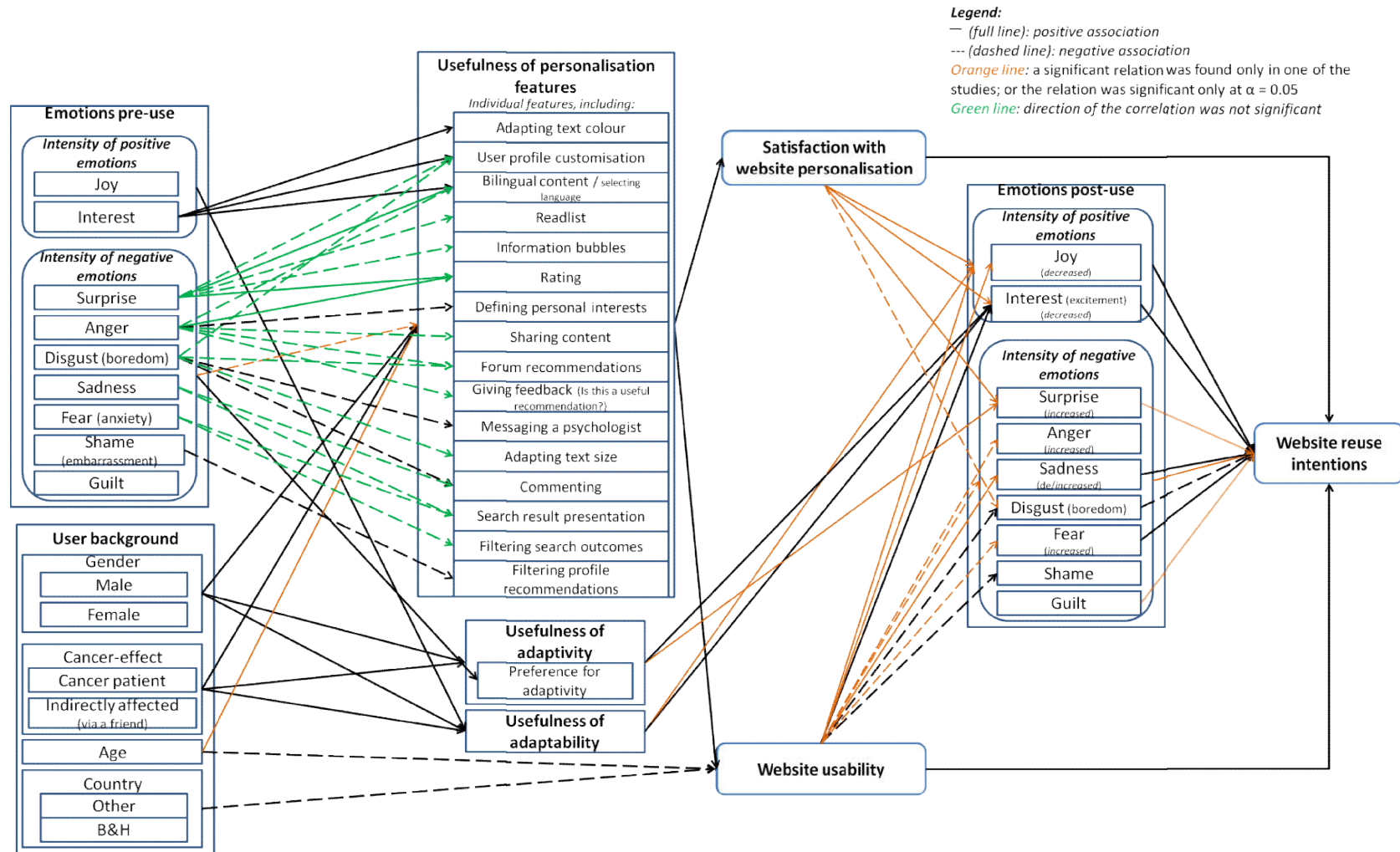


Figure 9.1. Revised model of factors affecting reuse intentions for a personalised cancer website

Finally, the research findings support the **third proposition** (RP3, the third group of theories, Chapter 3, Section 3.2.1.3). *Satisfaction with* and *usability* of the personalised website, along with the *emotions* evoked after website use, influence *intentions to reuse the website*. Being satisfied with the obtained personalisation and considering the website usable increases reuse intentions. Moreover, unexpectedly, *reuse intentions* are further significantly *stimulated* by fear and sadness, along with the expected positive emotion – interest.

Stemming from the presented findings are several **extensions to the theories** that were the foundation of this research. **Information foraging theory** [194, 195] has been applied in understanding the search for online health information. However, this research also showed that it can be used to explain how *gender*, *cancer-effect*, potentially age, and *importantly emotions*, *stimulate* users of cancer websites to *search* for specific website content and choose to *interact with specific website features*.

The **affect theory** [196, 197] and **broaden-and-build theory** [200, 201] specifically explain the driving force of human emotions. This research showed that the two theories are applicable to user interactions with personalisation features on cancer websites; that *emotions* users come to the website with will *influence how users perceive the website's personalisation*. *Emotions* will drive user attention to some features and away from others; they will *define user behaviour* and, hence, *shape their preference for and choice of which features to interact with*. This research confirmed the arguments of the two theories, specifically concerning positive emotions. People who come to the website feeling *negatively* are *likely to focus their attention on the narrow area of their concern* (this primarily being website content), and are *thus more likely to be negative about additional services, such as personalisation*. However, positive emotions tend to incentivise users to explore, to be flexible, seek new ideas and activities and hence engage with a variety of different personalisation features. Therefore, *positive emotions are more likely to stimulate a positive opinion about the personalisation services, particularly those that require user involvement and a level of user control, such as adaptable features*.

The ***principle of least effort*** [204] has been used in the context of personalised content recommendations for online news services and knowledge management systems [193]. This research further extends the theory to personalised recommendations provided on cancer websites. My findings show that when users of cancer websites are *guided to personalised content and useful features* – those that best reflect their preferences, needs, interests and even emotions - *users will be satisfied with the website services*.

Usefulness and *satisfaction*, *usability*, *post-use emotions* and *reuse intentions* are factors adapted from the ***UTAUT2 model*** [169]. My research suggests that the UTAUT2 constructs can also be used in explaining *reuse intentions for personalised cancer websites*. Usefulness of personalisation directly increases usability of and satisfaction with a personalised website. In turn, usability and satisfaction, as well as the majority of post-use emotions, work toward increasing the intentions to reuse the website.

This research further implies new applications of the ***affect theory of social exchange*** [215]. My findings show that, indeed, *users of a personalised cancer website are willing to exchange personal interests, preferences and emotions to obtain useful personalisation*. If users are *satisfied with the personalisation*, find its services *useful* and overall the website *usable*, they will feel rewarded for their actions. They will perceive that the exchange of information was worth the while, and hence will experience an *increase in positive emotions*, but also a *decrease in negative emotions*. Thereby, this research also indicates the applicability of *appraisal theories* in this context, by showing that ***personalisation of a cancer website can influence affective reactions***.

Finally, the ***rational choice theory*** [213, 214] provides insight into a website user's decision making process. This research was, to the best of my knowledge, the first application of the choice theory in explaining the *decision to use certain personalisation features over others*, as well as the *decision to return to a personalised cancer website*. This research shows that indeed *certain user background characteristics*, and more importantly their *affective needs and states*, *define the type of features and content users will choose to interact with, prefer over other, and conceive as useful*. This research further suggests a straightforward relation with reuse intentions; *as long as users are*

satisfied with the cancer website personalisation, they will decide to come back to the website.

The dependency model illustrated in Figure 9.1 encompasses the findings of this research, that were fostered by the three research propositions and founded in the revisited theories. The revised research model implies that future theoretical frameworks for cancer website personalisation, as well as those exploring factors influencing technology acceptance, should take emotions into consideration in the decision making process of both - using website's personalised services and using the website itself.

9.1.2 Practical implications

This research offers several practical implications. These are based on the findings showing the influence of pre- and during-use emotions on preference for website features, and the relations between post-use emotions and reuse intentions.

Implication 1. In devising user profiles for personalisation, it is important to attend to user interests and certain demographic characteristics. However, recent research has indicated that user models should be extended with user emotions. My research showed that for cancer websites, emotions can be used as a personalisation parameter. Different affective states evoke different needs, and therefore a cancer website should be adapted accordingly.

As of recently, extensive research on *emotion-based recommendations* has been carried out, particularly in the area of context-aware recommenders. Previous research has shown that incorporating emotions as a context in generating recommendations significantly improves the predictive performance of the algorithm, compared to the case where only non-emotion-related contexts are considered [186]. The findings in this thesis have also shown that cancer website users find personalised content recommendations one of the most useful website features. And, while users prefer the recommendations to be primarily founded in their cancer-related interests and content preferences, in long-term

website usage, it is desirable to have an additional level of filtering, which is adjusting recommendations to user emotions.

Therefore, content recommendations on cancer websites should be personalised to user emotions. This research thus suggests that *if a user preferred a content item in a specific affective state, the next time the same affective state stimulates her/him to visit the website in search of personalised cancer information, similar content should be recommended*, as that will best reflect the user's needs. The emotion-based content recommendation algorithms presented in Chapter 5 could be used as a starting point on which to extend upon (optimisation is discussed in Section 9.3).

Implication 2. Inducing a positive perception about the website's personalisation can be achieved by providing users the services they will find useful and therefore also want to interact with. Thus, based on this research, cancer websites should provide their users with the following *features*, as these are generally perceived as useful:

- *content recommendations for factual articles;*
- *user profile for defining personal interests and preferences;*
- *providing feedback for content (e.g., content rating or evaluating recommendations);*
- *and search and filtering functions.*

Implication 3. The results of this research suggest that *cancer website users primarily focus on the content of the website*. Moreover, they are normally *more interested in factual content of articles and the knowledge base*. Furthermore, the features and content a user will choose to interact with will depend on who they are visiting the website for and which visit to the website it is. After becoming more familiar with the website, users are *expecting the website to have gathered sufficient information about their content preferences, interests and emotions to be able to give them relevant recommendations*, and thus choose to view the recommendations on the profile page.

These findings can be expressed in the following rules:

1. IF it is the ***first visit*** to the website AND if searching for information *for someone else*, THEN show ***Knowledge base content***, and ***filters*** for filtering content ***by cancer type***, as the user would look for factual content, and particularly use the filters.
2. IF it is the ***first visit*** to the website, THEN show ***Articles*** related content, as the user is *likely* to also visit Articles.
3. IF it is the ***first visit*** to the website, THEN show ***Forum*** and ***Chatroom***, as the user would potentially explore Forum content and Chatroom visitors and conversations.
4. IF it is the ***third or later visit*** to the website, THEN guide the user to the ***User profile page*** and show the ***content recommendations***.

Implication 4. Emotions determine whether a user wants to participate in tailoring the website or prefers to let the system assume control. *Negative emotions stimulate users to prefer adaptivity*, thereby the website should respond by offering adaptive features, and hiding those features requiring significant user involvement. *Positive emotions*, on the other hand, induce *positive perception of adaptability*; therefore, the website should respond by pointing out features which enable users to personally customise the website. Hence, the following rules are devised:

1. IF a user reports at login *intense negative emotions*, THEN the website adjusts the *personalisation approach* to *adaptivity* AND *hides* the *personalisation features* that require additional user involvement.
2. IF a user reports at login *intense positive emotions*, THEN the website *highlights* the *personalisation features* that enable users to customise the website and their profile information.

Implication 5. *Discrete emotions predict the features users will like to have offered and those they will dislike.* The complete set of rules for ***emotion-based feature adaptation*** is presented in Appendix O. Here extracted are only the most prominent rules, which have been implemented on the latest PORT website (Phase IV version), and have been

evaluated and confirmed by significant correlations and/or prediction rules in the last study. Hence:

1. IF a user reports at *login interest* of greater intensity than *mild* THEN the website *highlights* the feature for *language selection*.

Users who visit the website with any level of interest gladly engage with the website, and hence like to adjust website features themselves. Therefore, a website should allow interested users to select the language themselves, by guiding them to the feature.

The following rule also holds for *language selection*:

2. IF at *login interest* intensity is *mild* or less,
OR
IF at *login interest* intensity is greater than *mild* AND *surprise* is *not felt at all*,
THEN the website applies *adaptivity* for *language selection*.

Since this refers to an essential feature, enabling users to switch to the language they understand, it is not recommended to hide it. Rather, website providers could decide to apply adaptivity, whereby user location could be detected and trigger automatic adjustment of the website language.

Furthermore, anger has been shown to negatively affect the use of certain features, as follows:

3. IF a user reports at *login anger* is *not felt at all* THEN the website highlights the following features: *forum discussions recommendations* AND *editing interests* within user profile;
4. ELSE IF *login anger* intensity is *mild* or higher THEN the website hides the following features: *forum discussions recommendations* on Forum main page by *changing their background colour* to a less visible or more transparent one; AND within the Edit profile page the *interest categories* by replacing them with only a *Define interests* link which, if clicked, presents all interest options.

If a user comes to the website not experiencing anger, it is likely they will want to explore alternative website content, connect with other users to share their cancer experience, and be in charge of expressing which cancer information interests them. Thereby, these users can be guided to the features they are likely to find useful (e.g., by highlighting them, as on the PORT website). On the other hand, if a user is angry, then these features should be hidden.

Two other strong rules have been discovered. The first shows that the *same discrete emotion can have a different effect on two similar features*, for example the effect of fear on different filtering features:

5. IF a user reports at *login fear* = 0
THEN the website highlights the features that enable *filtering* and sorting of *search outcomes* AND hides *filtering by cancer type*
6. ELSE IF *login fear* >=1
THEN the website hides the feature for *filtering search outcomes* by presenting only a link 'Filter' AND highlights *filtering by cancer type*.

The next rule indicates that *different intensities of the same discrete emotion can have the same effect on a feature, depending on whether the emotion was experienced at login or during website use*:

7. IF a user reports at *login interest* >= 1 THEN the website *highlights* search tools, including *search boxes* on Home page, on Blogs and Forum main page.
8. IF a user reports *during website use interest* <= 2 THEN the website *highlights* search tools, including *search boxes* on Home page, on Blogs and Forum main page.

Interestingly, another rule can be extracted from *Implication 3* and user interactions with the personalised cancer website (Appendices K, M and N). Whereby:

9. IF a user reports at *login interest* ≥ 1 OR *during website use interest* ≥ 3 THEN the website *highlights* the link to the *user profile* page.

The rule shows that the more interested a user is, the more likely they are to visit their profile page. However, while they find the content recommendations on the profile page useful when experiencing interest (Appendix M), they appear to be less likely to explore them, based on the longitudinal website usage data (Appendix K). This rule is not part of the Phase IV adaptation rules. Previous studies indicated rule 9, however the findings were not significant. The rule was confirmed by the Study 5 classification rules extracted from user interactions with the Phase IV PORT website (Chapter 7, Section 7.6.5.4).

Related to Implication 3, the following rules (10 and 11) establish the type of content and features more commonly searched for on a cancer website. Firstly, the positive emotion – interest – is linked to articles and news content:

10. IF at *login interest* is *very intense* THEN the website *highlights* links to *articles* and *news* content, by highlighting the Articles link in the main website menu, and articles' titles and *articles' recommendations* on all website pages.

The next rule stems from the positive influence of sadness on searching for articles:

11. IF a user reports at *login sadness* of intensity greater or equal to *mild* THEN the website *highlights* links to *articles* and *news* content, i.e., Articles link, articles' titles and *articles' recommendations*.

Finally, one of the ***strongest rules*** identifies the type of content to recommend for negative emotions, as follows:

12. IF a user reports at *login disgust* of intensity greater or equal to *moderate* THEN the website *highlights knowledge base* content.

Users experiencing negative emotions at the start of website use, particularly *disgust* of high intensity, prefer to view factual content. Thus, a cancer website can assist the user, by guiding them to Knowledge base articles, by *highlighting* the *Knowledge base link* in

the main website menu, and highlighting Knowledge base *articles' titles* and *recommendations* on all website pages.

Implication 6. Stemming from the last rules in Implication 5 is the following rule:

1. IF the website *highlights factual cancer content* (i.e., knowledge base articles and news), attracting user attention to its content, AND provides *useful personalisation*, THEN *the intensity of interest, surprise, sadness and fear will increase* AND the user will be more likely to *revisit the website*.

This rule is further based on the confirmed research model relations presented in Figure 9.1. Whereby:

Useful adaptive and adaptable features, and usability (potentially also *satisfaction*) **intensify interest**; thus consequently *website reuse intentions increase*.

Useful personalisation increases satisfaction with personalisation, which likely **increases** intensity of *post-use positive emotions*; thus consequently *website reuse intentions increase*.

Useful personalisation increases website usability, which **decreases** the intensity of *disgust* (OR boredom), and likely **increases** the intensity of *sadness*; thus consequently *website reuse intentions increase*.

Useful adaptive personalisation features and satisfaction with personalisation likely **increase surprise**; thus consequently *website reuse intentions increase*.

Interestingly, fear is a unique case, as personalisation does not have a positive effect on it, yet fear increases reuse intentions:

IF *fear* is *evoked* or intensified post-use THEN **intentions to reuse** a personalised cancer website **increase**.

Fear is not significantly affected by satisfaction or usefulness of adaptive or adaptable services. Moreover, perceiving a personalised website as usable likely decreases fear. Thus, as suggested in the discussion, and the previously mentioned rules, it could be that cancer information, which users find on the website, itself elicits fear.

9.2 Limitations of the research

As any research, the one presented in this thesis also has its limitations. They invite future research, addressing those challenges.

9.2.1 *Experimental design*

One of the *main limitations* resulted from the **experiment** and **survey design**. The experiments in this research prescribed mostly *short website usage time*, normally up to 20 minutes. This potentially did not enable first-time users to fully familiarise themselves with the personalisation on the PORT website, particularly the emotion-based personalisation, and more so to notice and interact with all its features. This limitation was also reported in previous research that evaluated health website content [11, 32]. Longer usage over an extended period of time would have potentially allowed users to better familiarise themselves with the new website features, particularly those they might not have had an opportunity to use on other online services. I attempted to alleviate this limitation by conducting interviews with a few long-term users of the PORT website (Appendix J) and by performing one longitudinal study (Appendix K).

The *experiments which required interaction with multiple versions of the PORT website* might have additionally confused participants. These websites were for the most part very similar - they purposely contained the same content and had similar appearance, to stimulate users to focus on the differences in personalisation. However, these differences would have been subtle to first-time users of the website. This limitation could have potentially reflected on user responses; an issue also encountered in previous research that evaluated multiple similar websites [32, 332]. Nevertheless, academic research generally has restricted resources. Moreover, in this research, attempts were made to alleviate the issues resulting from research design by: employing *between and within subject design*; *dividing the follow-up study into smaller experiments*, with separate participant groups; conducting a *longitudinal study*; and performing *several interviews with repeat users of the PORT website*.

In comparison to the relatively short website interactions, the *evaluation surveys were long* and included a large number of questionnaire items. Consequently, the length of the experiment and number of survey questions might have affected the response rate and a more frequent occurrence of straight lining, i.e., random responses. Nevertheless, in all the studies attention was paid to thoroughly *clean the data and only consider complete and reliable responses*. Moreover, the questionnaires in the later studies included *trap questions* to spot random responses, as well as randomising the question order to reduce the effect of fatigue (Chapter 4, Section 4.3.1.1). Finally, *Cronbach's Alpha* was applied to all the research constructs to test the reliability and internal consistency of the constituting items (Chapter 7, Section 7.2.2).

Moreover, the *usefulness instrument* of the survey questionnaire evaluated a large number of personalisation features. Given the short website usage time, it is possible that participants did not interact with all of the features. Hence, instead of evaluating the usefulness of a feature they used, participants potentially reported whether such a feature would be useful for a cancer website. This issue was addressed in Study 5, where participants were explicitly instructed to interact with the features they were immediately afterwards asked to evaluate. Similarly, in Study 4, a link to the *User guide for PORT website features* (Appendix E) was provided. Moreover, Study 4 also allowed participants to state that they *did not notice a certain feature*.

Furthermore, participants performed *experiments in different settings*. The experiments conducted in *computer laboratories* could have reflected on participant engagement in the survey and their privacy due to restricted seating arrangements. The participants were sitting next to each other, which often allowed the neighbours to see each others' monitors. It can, therefore, be presumed that some level of distraction while interacting with and evaluating the website did occur. Such limitations of conducting experiments in computer lab settings were also pointed out in previous research (e.g., [32, 54]). Thus, additionally, the participants in this research were asked to complete the survey on their own, to avoid the influence of other users.

On the other hand, experiments in lab settings had the advantage of being *supervised* by the researcher (myself) or an assistant (see Chapter 4, Sections 4.2.1 and 4.4). Hence, supervised participants were also more promptly provided help with any ambiguities in the questionnaire or with issues during website use. However, the presence of the researcher could have affected the responses - positive and negative bias - particularly among student groups. Nevertheless, it is likely that the positive and negative biases neutralised each other - especially in comparing the website versions.

9.2.2 User training: Exposure to novel technology

Engaging users in user interface (UI) evaluations requires a level of training, as time is required to gain expertise, irrespective of the UI's simplicity [333]. However, quality UI design – measured commonly by its usability, and more recently by affective factors (e.g., trust, enjoyment) [334] – is more intuitive and, as such, requires less explicit training [335]. If we take Facebook as an example of quality UI design, users do not necessarily have to be trained to engage with and adopt their various features. Nevertheless, what has to be taken into account is the difference in the approach and aims of this research and the commercial online services, as is Facebook.

Firstly, Facebook has the comparative advantage of a large online service, with a big user base. They are thus able to introduce new functionality that might not be used in the beginning, or users might be initially overwhelmed by, however, they have the leverage to allow users to gradually familiarise themselves with the new features and eventually adopt them. An online service just introducing itself to users, as is PORT, does not have these privileges. Moreover, the main concept of the PORT website – emotion-based personalisation - was something users have not been exposed to before. Furthermore, one of the main aims of this research was eliciting user feedback about these new, unfamiliar, functionalities. User feedback (emotions and evaluations of emotion-based features) was also essential in developing and refining the emotion-based personalisation and adaptation services.

Secondly, the findings of this research imply that a good UI design might not be the only and main determinant of the requirement for user training. Reuse intentions for all versions of PORT - personalised and non-personalised – were high. Given that the same UI design was used on all website versions, this indicates either that UI design was not the factor affecting user acceptance of PORT, or that users perceived the PORT UI is of good quality. Furthermore, in evaluating PORT website's usability, users mainly agreed they would not need a technical person's support and that it would be easy to learn to use the website. While this research did not explicitly measure the quality of PORT's UI, the results indicate there are factors other than the UI design that potentially better explain the ambiguity in user preferences between the personalised (unfamiliar, innovative services) and the non-personalised website versions. Hence, such factors explain why participants in research of this type would benefit from prior explicit training in online services they have not encountered before, irrespective of the quality of UI.

Primarily, the PORT website was predominantly interacted with and evaluated by first-time users. Moreover, these users were not familiar with emotion-based personalisation, as the commonly used online services have not yet adopted this technology. Thus, it would have been preferable to acquaint users with the new features' functionality and benefits – via user guides or other types of training. This research did train users at two stages: in Study 4, user guides for PORT accompanied the evaluation questionnaires; in Study 5 interviews, different features on the three versions of PORT were demonstrated to participants. In the latter case, the positive influence of prior training in understanding the emotion-based functionalities was evident.

According to the Zajonc's *mere exposure effect* [336], human beings are generally cautious to novel stimulus. That what we are familiar with induces cognitive ease, and thus greater liking [336]. Therefore, in evaluating a novel technology, as is emotion-based personalisation, first-time users of the PORT website could have experienced cognitive strain and cautiousness, which potentially reflected negatively on their perception of this technology. The effect of mere exposure is particularly evident in the findings comparing the PORT website with emotion-based personalisation (novel, unfamiliar features) and generic personalisation (familiar features, commonly used in

other online services). First-time users of the PORT website were potentially positively biased towards the technologies they generally use (e.g., Facebook and its approach to reporting affective reactions), and thus likely formed a negative attitude toward the unfamiliar PORT features (e.g., the Emotion Tool, emotion-based content recommendations and feature adaptation). Interview findings with long-term PORT users further show that familiarity and awareness supersede the initial apprehension. Familiarisation, thus, incentivises technology acceptance, liking, or at least a more objective evaluation of novel services in comparison to those a user is accustomed to.

The findings of this research and the background theories imply that, while quality of UI should be observed, as it positively reflects on cognitive and affective appraisal of the system [334, 337], other factors should also be considered to determine the need for and extent of training required for user evaluation and adoption of a novel technology. It is thus advised here that future studies include explicit training; especially those studies that focus on evaluating novel services (e.g., evaluation of emotion capturing and emotion-based personalisation on PORT). Prior familiarisation is expected to lead to a more objective and reliable evaluation of the technology the user is asked to interact with.

9.2.3 Sampling

In the five studies of this research, the **number of participants** was lower than the recommended sample size. Generally, larger samples are recommended, to ensure the statistical power of tests [338]. However, a large sample size is sometimes difficult to achieve, due to the nature of the research, and abiding strictly to it could discourage research efforts, which generally have limited resources [338]. Moreover, previous research related to emotions and HCI, which also included experiments and lengthy surveying, recruited comparatively smaller groups of participants. For example: 66 students participated in [54], 78 students in [140], there were 26 and 16 participants in a field study and controlled study, respectively [43], 60 participants in [84], 28 subjects evaluated the real-time subjective emotionality assessment system [152], 24 participants evaluated the effect of emotions on search processes [149], 34 university students were

included in a study exploring emotions experienced on e-commerce websites [151], and 40 students evaluated health website usability and functionality [11]. Hence, the number of responses collected in the studies of this research is comparable with similar research.

Relatedly, the **non-probability sampling methods** used in this research were prone to bias. However, attention was given to applying triangulation approaches (surveying, interviews and website usage data), and conducting multiple studies, to increase the reliability of responses and their external validity. The sampling methodology may have resulted in an unequal *gender distribution*. Female respondents were overrepresented in some of the studies of this research. Internet is the first resource for health information for both men and women [65]. Nevertheless, gender was repeatedly found to influence online health information search [63], women being more inclined to it [64, 217]. Even though the proportion of male participants in some of the studies of this research was smaller, it showed that men use the Internet to find health information, and are an important segment of the targeted population. Nevertheless, given the bias towards females, care should be taken in applying the findings to cancer services exclusively targeting the male population.

Moreover, relatively few *cancer-sufferers* have been included. Thus, *indirectly affected people* may have also been overrepresented in the sampled respondents. However, cancer incidence rates and the sample calculations applied to this research show that such a proportion is to be expected in studies involving people directly and indirectly affected by cancer. Moreover, interviews in this research were primarily carried out with cancer patients and survivors to obtain their direct, extensive feedback about the website services.

Surveying students is also a limitation. The inconclusive findings, related to user preferences for the level of personalisation on cancer websites, could be attributed to the prevailing type of participants, who were students. Previous research also indicated that sampling this user group is challenging, as these users are “digital natives”, highly exposed to technology and have high expectations [32]. The use of student samples in academic research has been debated for some time [11, 339], as such studies might lack

generalisability [11]. Moreover, students might not be the best representatives of the cancer-affected population. However, in all the studies of this research, participants were *instructed to express whether and how cancer affected them*. Furthermore, some studies supported the use of *student samples as more appropriate and typical users of online services* [11, 269], including online health services [64]. An additional advantage of my research is that it *expanded the participant pool by also sampling other population groups*. Moreover, it relied entirely on the other populations in the last, follow-up, study.

9.2.4 *Number and type of studies*

Another possible limitation could have been the **number of studies** performed for this research. This research was carried out in *five studies* with differing sample sizes. It was arranged in this way to gradually implement personalisation on the PORT website, and follow up each implementation phase with an evaluation study. The aim was to use each study's findings to adjust the requirements for the next phase of development, as well as to be able to compare the results of introducing different levels of personalisation. Some studies (e.g., Study 1) were *necessary to define requirements for website development*. Some *evaluated the use of new types of features or functionalities implemented on the website* (e.g., Study 2 and Study 4), or explored *an alternative research design* (e.g., Study 3 and Study 5). Other studies (e.g., Study 5) were *follow-up, confirmatory studies; they showed learning, resolved ambiguities or inconsistencies in the results*. Overall, the attempt was to abide to the user-centred method [297] - user involvement in system development from design to implementation – and the Scrum framework [340], to address volatile user requirements.

Furthermore, all five studies were *cross-sectional*. As previously explained, engaging users in a single short experiment potentially does not provide sufficient time to notice or completely experience all personalised services. *Longitudinal data* would bring insight into how users who are familiar with the website – its purpose, content and functionality – would use it, and provide a more in-depth understanding of how emotions stimulate repeat visitors to choose specific features to interact with. One such *longitudinal study*

has been performed in this research, although with a smaller group of participants. Additionally, follow-up interviews were carried out with a couple of cancer sufferers who were repeat visitors to the PORT website. Nevertheless, running larger scale *longitudinal studies requires the availability of different types of resources* through which it would be possible to stimulate, reward and oversee participation over a certain period of time. This research, on the other hand, was limited in the availability of financial resources, accessibility of the target users, as well as overall time.

9.2.5 Data analysis methods

The **statistical analysis methods** that were applied also introduced limitations. Conducting large number of correlation tests required taking into account the problem of multiple comparisons. The applied Bonferroni or Holm-Sidak corrections resulted in very *strict statistical significance levels* (for example below 0.0001), which thus also constrained the results of hypotheses tests. To alleviate this issue, results found at the 0.05 significance level were also reviewed and taken into account, if they were confirmed in several studies of this research.

9.2.6 PORT website content

A further limitation might have been the **lack of content** on the PORT website. Some of the content on the personalised PORT cancer website was migrated from the PORT's original website. However, in comparison to other commercial services that have been present on the Web for some time, content on the PORT website was scarce. Another issue was that the content was mainly available in either Bosnian or in English, but not both languages. Unavailable content in the language of their choice frequently caused user frustration, which could have been transferred onto the perception about the usefulness of certain personalisation features – e.g., bilingual content (discussed in Chapter 7) – and, moreover, on the usability of the website. Nevertheless, *improvements were made in Study 4 and 5* by translating as much content as possible into both languages, and providing language filters. Furthermore, in Study 5, experiments

prescribed which content to view, thus ensuring it will be available in the participants' language.

9.2.7 Extraction and design of emotion-based rules and algorithms

A potential limitation was also the **design** choice for the **emotion-based adaptation algorithm**. *Hard coding* was selected for implementing the rules for adapting website features and content to user emotions. Alternatively, *machine learning* could have been employed. However, machine learning requires the existence and accessibility of large amounts of data (about users and their activities). Currently, however, the PORT website is limited in this aspect. The website has sporadic users, who are mainly not registered. Moreover, these were mainly users recruited for the studies conducted for this research, the majority of which did not subsequently visit the PORT website. Therefore, applying machine learning would not have been efficient. Hard coding avoided these issues, and was a justified, but perhaps not the optimal, approach. Moreover, a similar approach - mapping adaptation rules - was used in previous related research (e.g, [33]); see Chapter 5 (Section 5.3.2).

Essentially, the aim of this research was not exploring different approaches to implementing emotion-based adaptation or algorithm optimisation. This was an *experimental, explorative research, with the objective to test whether emotions can be used to adapt cancer website features* and personalise recommendations, and to *establish target users' opinion about introducing emotion-based personalisation to a cancer website*.

Related to the above issue are *content recommendation algorithms*. The PORT website implemented content filtering and collaborative filtering techniques, depending on the type of the user. The emotion-based recommendations were based on comparing the aggregated affective states of a single user, or of two similar users. Unlike the emotion-based adaptation algorithm (A3, Chapter 5, Section 5.3.2), the current algorithms for content recommendations (A1 and A2) only consider aggregated affective states, but not *discrete emotions*. Moreover, emotion-based content recommendations are only

generated at login, while change in emotions during website use is possible, and hence recommendations could be adjusted accordingly. Overall, there is room to explore whether alternative approaches, for example context-aware recommenders, would affect the research findings. Moreover, there is a need to further optimise the algorithms' parameters, as this was not the main concern of this research. Optimisation was addressed to a limited extent in Chapter 5, and is discussed in Section 9.3 of this chapter.

9.2.8 *Emotions and website design*

Another aspect which was partially addressed by this research is the relation between emotions and website design. Website design includes affective elements – e.g., colour, images, shapes – which are used to induce emotions and emotional appeal in users [334]. Only focusing on usability as a determinant of quality in HCI has been criticised [341]. Recent research has thus surpassed the commonly used measures of website design, such as ease of use and usefulness, and expanded them with emotions-related factors [334], which were shown to have a significant impact on user experience [334].

For example, a good design can influence an unpleasant event (e.g., with 404 error pages) to be experienced with positive emotions, and thus evoke a more positive attitude toward the website [342]. Poor website design can, on the other, induce negative emotions [342]. Evaluations of the PORT website with emotion-based personalisation also indicated that user attitude toward the website might have been influenced by its design. In giving feedback on why they preferred the website with personalisation more than the non-personalised one, users claimed to be pleased with the simplicity of the website's appearance, navigation, and colours (resulting from adaptation).

As discussed in Chapter 3, according to the appraisal theory, emotions are reactions to events, objects or experience. Alan Cooper, president of the user experience design company Cooper [343], stated: "Humans have always been emotional and have always reacted to the artefacts in their world emotionally." [344] It is thus not surprising that visual and interaction design of online environments elicits affective responses [334].

Cyr [334] mentions four possible affect-based outcomes of user interaction in online environments, including: enjoyment, involvement, trust, and satisfaction. Cyr et al. [345] show in their multi-method research that website colours significantly influence user satisfaction and trust in the website. Trust and satisfaction also result from adopting social elements, e.g. user photos, on websites [334]. Pengnate and Sarathy [346] discovered that visual appeal has a greater influence on trust in unfamiliar websites than the website's ease of use. Research applied to online shopping implied that visual, navigational, and informational elements of website design significantly negatively influence shoppers' perceived irritation [347]. Furthermore, Bhandari et al. [348] presented several findings on mobile apps design, including that: visual aesthetics positively influence arousal of the affective state; quality of mobile app is positively affected by valence and negatively by arousal; moreover, that affective responses are an essential factor in understanding user appraisal of mobile app design. Thus, attractive website and app design is dependent on effective use of design elements - navigation, colours, and other visual aesthetics - as these reflect on user affective appraisal of the system they are interacting with [345].

However, while research in this area is growing, there is yet no definitive understanding of the relation between individual website design elements and user emotions [334]. Moreover, further research is needed to connect emotions and website design in different online contexts, such as e-health, social networks, gaming, etc. [334]. Thus, one of the major contributions of this research was exploring the effect of emotions on different cancer website features, in order to establish adaptation rules, including the adaptation of feature colours and design. Moreover, this research explored how post-use emotions are induced by satisfaction with the website personalisation (personalisation and adaptation reflect on website design elements) and by usability of a personalised website. However, future research should also consider the explicit effect of the design of a personalised cancer website on user emotions (during and ending), as well as the intrinsic affective factors in the website design process.

9.2.9 *Modelling and measuring emotions*

Additional limitation could have resulted from adopting the basic emotions' taxonomy, which identifies a universal [349], cross-culturally recognisable, set of emotions, rather than the emotions experienced in a specific context or by a specific population. Emotions experienced in a cancer-related context are likely different from those emotions prevailing in an online shopping or movie-watching context. Hence, prior consultation with representatives of a specific population – starting with cancer patients, their family members/friends (as in this research, e.g., in Study 1), and continuing with health professionals (which can be explored in further research) – is and would be beneficial for *modelling the context-specific emotions*. Through their experience in working with cancer-affected people, medical and mental health professional could provide additional valuable input in identifying and classifying the different emotions that this population commonly experiences in everyday living with cancer. Therefore, future research should address modelling emotions specific to the cancer-affected population's context.

Nevertheless, restricting research to a narrowed set of context-specific emotions does diminish the possibility for comparative studies - for example, comparing the effect of emotions on personalisation in the domains of online entertainment and online health services. Moreover, the validated emotion measuring instruments for self-reporting (e.g., SAM) owe their widespread use to the standardised set of emotion items, which is applicable across domains and enables generalising and comparing research results. Nevertheless, as this research considers the effect of different discrete emotions, input from clinicians and therapists would be beneficial in confirming the relevance of the selected nine basic emotions for determining the affective state of a cancer-affected person.

Furthermore, limited resources led to employing **emotion self-reporting**, while there are objective measures (e.g., skin conductivity, facial expression recognition), which are increasingly more relied on in emotion-related research. However, self-reporting is a commonly used method (e.g., [54, 141, 201]). Given that the *aim of this research was not exploring or improving instruments for measuring emotions*, self-reporting was selected

as the most convenient option. Moreover, my research strived to utilise affordable, reproducible and non-intrusive technology.

The use of a self-developed instrument could have also introduced certain limitations. Emotion Tool is an instrument for emotion self-reporting developed for this research (Sections 2.4.3, 3.3.2, 4.3.1.2, 5.2.3.4). The choice for this method was justified in Chapter 2 (Section 2.4.3).

There are existing validated instruments for emotion self-reporting, used commonly in the literature; for example, DES, SAM or mood reporting applications (Section 2.4.3). Another popular tool is the PANAS questionnaire [276], which was developed specifically to address the lack of internally consistent scales for positive and negative affects. However, PANAS focuses on mood scales [276], while this research abides by the argument that moods and emotions should be differentiated [130, 131] (Section 2.4.1). Moreover, while this research does consider the aggregated affective state's valence, the aim here was primarily to research the effect of emotions at a more granular level, i.e., to explore the influence of different discrete emotions. Furthermore, PANAS mixes 20 items of feelings and emotions (i.e., 10 items for each of the positive and negative mood scales). However, according to the results of this research, an extensive list of items in an emotion instrument on a cancer website decreases user willingness for self-reporting. What is more, the PANAS' emotion-related items are based on basic emotions, e.g., interest, shame, fear, sadness, which are integral items of the Emotion Tool.

Similarly, the Affective Slider [277], also a tool for emotion self-reporting, has evolved from the SAM instrument. Essentially, it simplified self-assessing the level of pleasure and arousal, by providing digital scales and modified illustrations of the scales (using emoticons instead of manikins), and by using sliders instead of the 1-9 rating points. Thus, the justifications presented in Chapter 2 on why SAM has not been adopted, applies to this tool as well.

Nevertheless, a valuable extension to this research could be a study on the applicability of the various alternative emotion-measuring instruments for cancer website emotion-based

personalisation. Specifically, future research should compare the various self-reporting emotion instruments, as well as other methods for emotion recognition, in terms of user willingness to report emotions, ease of use, acceptance of the tool for emotion-based personalisation on a cancer website, impact on user perception of website usability, and effect on accuracy of the emotion-based adaptation rules.

It should also be noted that the *validity of the Emotion Tool* instrument and the self-reported data was tested and compared to the results of a widely used self-reporting instrument – SAM. Validating emotions resulting from a stimuli – e.g. an event or object, as is a personalised website – is a commonly used approach, on which SAM itself was tested [140]. However, emotions at the start of website use are more difficult to evaluate. Pre-use emotion self-reporting is not uncommon; other studies also collected user affective states at the beginning of an experiment (e.g., [149]). The pre-use emotions were hence approached as any other question type, where users self-report their perception about a topic. There is always a possibility that participants respond randomly. Dealing with such issues is limited to: cleaning data of significant outliers or removing inconsistent responses.

Finally, there are other factors that potentially affect emotions, personalisation and reuse intentions, in relation to cancer websites, which can extend the conceptual framework of this research. This and other prospects for future work extending this research are discussed in the next section.

9.3 Future work

The findings of this research and its limitations have highlighted potential areas for future work. The scope of future research includes further *improvement of emotion-based personalisation for a cancer website, extending the research model with new factors, applying alternative methods for testing the model, and conducting longitudinal studies with larger samples of more precisely defined target users.*

The *main area* of consideration for future research is **improvement of cancer website personalisation**. Alternative approaches to the ones used in this research should be considered, including: adopting machine learning for emotion-based adaptation and optimising content recommendation algorithms.

Machine learning is expected to produce more accurate predictions, compared to the hard-coding approach adopted on the PORT cancer website. Machine learning techniques can be used to dynamically predict the type of adaptation to offer to individual users, based on their emotions. A prerequisite is to generate larger website usage datasets, whereby outreach activities can be performed, to draw additional visitors to the website.

Optimisation of the content *recommendation* and *adaptation* algorithms was outside the scope of this research. These are questions to be explored in future research, specifically focusing on recommender systems. However, optimisation could be applied in the following areas: user and content parameters (which user and content characteristics to take into account and how to weigh them); determining content preference by metrics other than the average content rating used in this research; employing algorithms other than the kNN algorithm for detecting similar neighbours (items or users); exploring other filtering techniques; adopting the latest approaches from context-aware recommenders, which have researched emotions and have shown that emotions as contexts improve the predictive performance of a recommender. Future work should evaluate whether optimisation of the algorithms would reflect on user perception of emotion-based personalisation on a cancer website. In other words whether it would increase website usability, user satisfaction and reuse intentions, and moreover result in a significant preference for this level of personalisation.

Future research could particularly look into *extending the emotion-based content recommendations*. The currently implemented algorithms on the PORT website only consider user aggregated affective states – positive, negative or neutral. However, future studies should look into the role of *each discrete emotion*, how they affect user preferences for content on a cancer website. Moreover, it should be taken into account that emotions potentially change while using the website. Thereby, content

recommendations could be improved by generating them not only from emotions experienced at the start of website use, but also from *during-use emotions*.

Alternative *methods for measuring user emotions* should also be considered in future research; for example more objective techniques, as facial expressions recognition. Whereby, the reliability of affective states detected by different emotion techniques should be compared. Moreover, the influence of the emotion measuring method on user perception about the emotion-based personalisation and the website itself should be evaluated.

The *next general area* for future research endeavours are **extensions to the conceptual framework**. Pre-investigations carried out for this research have shown that factors such as *privacy concerns* and *balance between personalisation and privacy* affect perception about cancer website personalisation or reuse intentions. Other research in personalisation [350] has researched *trust*. Previous research has shown that *privacy* and *trust* affect personalisation-related factors in other online domains [126] and behavioural intentions in online health services [64, 124, 351]. Given the sensitive nature of cancer websites, particularly personalised websites that collect different user data, *privacy concerns* and *trust factors* could potentially have a significant impact on target user behavioural intentions, and therefore, future research should consider incorporating them into the research model.

Thirdly, **alternative methods for research model testing** should be explored. The primary focus should be on applying *structural equation modelling*. This statistical analysis technique would allow testing the between-factors' relations and a more comprehensive understanding of which factors contribute to the reuse of personalised cancer websites, and which can be excluded from the model.

Another area the future research should focus on conducting is **longitudinal studies**. Longitudinal studies should provide a more reliable picture of target users' attitudes toward emotion-based personalisation on cancer websites. *Using the website over an extended period of time* would enable users to better familiarise themselves with how emotion-based personalisation functions – i.e., why they are asked to report their

emotions, to see the results of such actions and potentially see the resulting benefits. This way, *realistic settings are achieved that would provide reliable results in exploring user preferences for an innovative technology over other technologies users might be more accustomed to, and hence slightly biased for*. In fact, the latest version of the PORT website is already accessible online; it is supported by the PORT Association, and real-life users have started using it. Collecting long-term usage data on the PORT website about repeat/return visitor interactions will enable conducting further research on the use of emotion-based features.

Finally, **larger samples** of more precisely defined *target users* should be recruited. Preferably, the focus in sampling should be on younger age groups, of cancer sufferers and those affected via a family member or close friend, who are either facing cancer at the moment or have recently had experience with it, and who have used the Internet to search for cancer information. In obtaining larger samples, crowd sourcing services can be used to reach participants from different world regions, to have as global a population of cancer-affected people as possible.

In summary, future research should answer the following questions: *whether repeat visitors and long-time website users uphold their implied preference for emotion-based personalisation on a cancer website; whether longitudinal website usage data reveals different patterns between emotions and the features/content users choose to interact with; whether applying machine learning to adaptation rules can improve emotion-based personalisation outcomes; whether privacy and trust affect reuse intentions; and whether the use of alternative emotion recognition methods leads to more reliable identification of user emotions and thus improves emotion-based personalisation.*

9.4 Conclusion

Despite the increasing efforts to raise cancer awareness and find new treatments and cures, cancer remains an incurable disease in the majority of cases, with one of the highest mortality rates. It is a disease which affects, directly and indirectly, a large part of the world population, leaving profound traces on the lives of those affected. Those

fighting cancer, thus, rely on various types of support to ease the treatment process, to socially and emotionally adapt to life, and deal with the grief of losing a loved one.

Particularly attractive cancer support options are the widely accessible online health services. Hence, this research explored health websites providing various types of cancer support. However, it addressed the topic from the perspective of introducing personalisation services, adjusted to the needs of different categories of people affected by cancer, to improve the online cancer support. Personalisation has been extensively researched and was shown to improve usability and user acceptance of a technology. According to the reviewed literature, health websites are lagging in the adoption of personalisation. An additional challenge is implementing adequate personalisation for cancer websites. User needs differ from person to person, but also from one online domain to another.

Personalisation has traditionally relied on profiling users based on their demographic information and online behaviour. However, research advocates extending user profiles to create a comprehensive understanding about a user, which incorporates, among others, user emotions. This is particularly applicable to online health service users who are affected by cancer, as cancer has a significant impact on the affective state. This research, thus, argued and demonstrated that *addressing the personalisation needs of cancer website users also entails responding to the emotions* users are experiencing at a particular website visit.

Emotion-based personalisation is a relatively new and growing research area. Research connecting emotions and personalisation has been applied to several online domains; nevertheless, the focus has been on recommender systems, specifically in online entertainment (movies and music), and to some extent in e-shopping and e-learning. The results of previous research have been promising. Due to the type of users and the online domain it focused on, this research thus ***contributed to the existing literature by exploring the adoption of emotion-based personalisation on a cancer website and evaluating user preferences for this type of personalisation.*** This was achieved through seven research objectives.

Thereby, in reaching the stated objectives, this research made two concrete *contributions*. In response to the **first research question**, and based on the data collected from the predominantly sampled first-time users, who are indirectly affected by cancer, *emotion-based personalisation is preferred on a cancer website, however, not significantly over generic or no personalisation*. Importantly, this research implied that users find personalisation on a cancer website useful, and websites with personalisation, particularly with emotion-based personalisation, are considered more usable. Moreover, repeat website visitors decidedly *prefer to use the website with emotion-based personalisation*.

With respect to the **second research question**, it was shown that *emotions do influence both the perception of personalisation and reuse intentions for a cancer website*. Nine discrete emotions (interest, joy, surprise, sadness, fear, disgust, anger, guilt, shame) of different valence were researched in depth. Emotions influence which features users will find useful and interact with, as well as user behavioural intentions with respect to reusing a personalised cancer website. Moreover, emotions also result from interacting with the website. Interestingly, however, the *effect of emotions* or the *effect on emotions* should not be generalised solely based on their valence. The findings of this research implied that emotions should be explored as discrete states, rather than valence-based aggregations, in order to understand their relations to user appraisal of personalisation services, in the context of cancer websites.

Positive emotions seem to be operating in the same direction and, as expected, they improve the perceived usefulness of personalisation and increase reuse intentions. Moreover, they are evoked and intensified by a useful, usable and satisfying personalised website. However, it is the emotion *interest* that assumes the leading role among the positive emotions.

The relations with *negative emotions* are not as straightforward. While most of the negative emotions studied here affect user perception about some aspect of cancer website personalisation, and they do so negatively, there are some negative emotions that show an opposite effect. These are, for example, *anger* and *surprise*, which negatively affect the usefulness of some personalisation features, but improve it in other instances.

Similarly, positive user appraisal of a personalised cancer website, when explored in terms of usefulness, satisfaction and usability, mainly decreases the intensity of negative emotions. However, interaction with a personalised cancer website evokes or intensifies *surprise* and *sadness*.

Another unexpected effect is that of discrete negative emotions on reuse intentions. Interestingly, *the majority of the studied negative emotions appear to be working jointly with positive emotions toward increasing reuse intentions*. Nevertheless, some negative emotions either do not affect reuse intentions or they influence it negatively.

The findings of the two research questions were used in devising ***emotion-based rules for content recommendations and feature adaptation for cancer website personalisation algorithms***. This was one of the **main research contributions**. Another ***practical contribution*** of this research was the *implementation and evaluation* of the research findings through the *development of the **PORT cancer website***. The *personalised cancer website* was developed exclusively for this research, in agreement with the PORT Association, and has been *publicly available for real-world use* since its last development phase in 2016. Dividing the development of the website into several phases enabled experimenting with and exploring the introduction of different personalisation options. *Target users were, thereby, gradually introduced to different types of personalisation services*, and in doing so it was possible to obtain and compare user perception about each level of personalisation.

Finally, this research ***contributed*** by ***extending the existing theory*** on emotions, technology acceptance and behavioural intentions, with a **research model linking emotions with personalisation, and with reuse intentions, in the context of personalised cancer websites**. Providers of health websites for people affected by cancer should recognise that catering to user emotions, by providing emotion-based content and feature personalisation, could increase user interest in the website and hence motivate the use (and reuse) of (personalised) cancer websites.

In conclusion, this research has resulted in a *personalised cancer website available for commercial use by people affected by cancer worldwide*. It proposed an *approach to*

introducing emotion-based personalisation to cancer websites. It recommended the *type of emotions and features* to focus on in *personalisation algorithms*. Theoretically, this research *proposed a conceptual framework* for exploring behavioural intentions to reuse personalised cancer websites. It indicated that *personalisation-related constructs should be considered in theories and models* addressing technology usability, user acceptance, choice theories, affect and social exchange. It showed that both affect and choice theory are applicable to users of personalised cancer websites. That is because *people's emotions influence which personalisation services they will choose to interact with, as well as their decision to reuse personalised online cancer services*. These findings are important for cancer website providers – to increase website visit rates and possible revenue or customer base. More importantly, in the greater fight against cancer, *this research translates into a more informed population for prevention purposes, and a more satisfied cancer-affected population, provided with more relevant and improved cancer support*.

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Appendix A

Emotion Tool: Reliability of the emotions measuring instrument

This section validates the Emotion Tool as an instrument for reporting and measuring emotions. The Emotion Tool was compared against the Self-Assessment Manikin (SAM), which is also a self-reporting instrument validated through numerous studies and used in a variety of research areas [43, 140, 150, 152, 352]. The SAM was used with the obtained written permission of the authors [140, 155]. The SAM was incorporated into the Emotion Tool provided on PORT website¹⁵, as illustrated in Figure A.1.

Additional experiments were carried out in Study 4 and Study 5 to validate the Emotion Tool by answering the following:

Do the results on user affective state coincide for the Emotion Tool and SAM, as two emotion self-reporting instruments?

It was hypothesised that:

H A1: High intensity in positive emotions reported via the Emotion Tool is associated with feeling pleasant in valence, calm in arousal and dominant in dominance scale of the SAM.

H A2: High intensity in negative emotions reported via the Emotion Tool is associated with feeling unpleasant in valence, aroused in arousal and dominated in dominance scale of the SAM.

A.1 Study 4: Experiment for testing the validity of the Emotion Tool

In a controlled setting, 10 students attending a Master's level course in Computer Science participated in a 40-minute experiment with the PORT website. Four tasks were

¹⁵ Phase III version of the PORT website: <http://dev.port.org.ba/>

prescribed, which included visiting and using the functionalities of different segments or versions of the PORT website, for example: Edit profile, Articles and My Profile. The final task instructed participants to interact with the non-personalised version of the PORT website. After completing a task on the website, the researcher instructed the participants to report their affective state using the two self-reporting instruments. Data was collected via an online questionnaire, which presented two questions, as follows.

The first question asked the participants to report their emotions using the instrument developed for this research. It stated:

The content/features you have just viewed/read/interacted with on PORT's website evoked which of the following emotions, and to which extent?

The 12 emotions explored in Study 3 were listed and a 5-point scale for intensity was used as follows: 1 - not at all, 2 - mildly, 3 - moderately, 4 - very, and 5 - extremely.

The second question asked the participants to report their affective state using the SAM. It stated to *rate how the content/features the participants have viewed/read/interacted with on the PORT website made them feel on the three below scales*, where:

- Valence refers to the level of feeling: Happy vs. Unhappy
- Arousal refers to the level of feeling: Excited vs. Calm
- Dominance refers to the level of feeling: Controlled vs. In-control

As illustrated in Figure A.1, participants were shown the SAM manikins for each dimension. They were told to report their affective state by selecting the number (on a 1-9 scale) that corresponds to the extent of how the participant felt on the specific dimension. For example, for the valence dimension, participants were shown the 1-9 scale and the manikins, and explained that the left most, corresponding to number 1, was to be selected if the participant felt very pleasant, while the rightmost manikin with a sad face (number 9), refers to feeling very unpleasant. The remaining two dimensions were also explained in the same manner, showing the manikins that represent the scale and correlating each manikin to the number on the scale. Thus, for the arousal dimension, the left most manikin corresponded to 1: aroused, and the rightmost to 9: unaroused. While in the case

of the dominance dimension, participants were asked to select 1: dominated if they felt very controlled after carrying out the task, up to 9: dominant, which corresponded to the participant feeling very in-control.

This will enable us to provide you feature and content recommendations tailored to your emotional state.

	Not at all		Moderately		Extremely
Surprise	1	2	3	4	5
Anger	1	2	3	4	5
Joy	1	2	3	4	5
Sadness	1	2	3	4	5
Disgust	1	2	3	4	5
Fear	1	2	3	4	5
Shame	1	2	3	4	5
Guilt	1	2	3	4	5
Interest	1	2	3	4	5

Valence (extent of feeling happy/pleasant vs unhappy/unpleasant)

pleasant: 1 2 3 4 5 6 7 8 9 unpleasant

Arousal (extent of feeling aroused/excited vs unaroused/calm)

aroused 1 2 3 4 5 6 7 8 9 calm

Dominance (extent of feeling dominated/controlled vs dominant/in-control)

dominated 1 2 3 4 5 6 7 8 9 dominant

Save

Figure A.1 Emotion Tool with SAM dimensions

A.1.1 Test 1: ET and SAM correlation analysis

IBM SPSS v22 and Microsoft Excel were used for data preparation and analysis. Ten responses were collected for each of the four tasks. The resulting dataset consisted of 40 cases. The cases were represented with the variables: user ID, task (task number 1-4), 12

variables corresponding to the discrete emotions measured via the Emotion Tool instrument, and 3 variables representing the 3 dimensions of the SAM. Table A.1 shows the summary statistics for the 15 emotions-related variables.

Table A.1. Summary statistics for the 12 Emotion Tool emotions and the 3 SAM dimensions

	Mean	Mode	SD
Fear	1.54	1	.822
Interest	3.33	2	1.132
Happiness	1.85	1	.988
Excitement	1.62	1	.935
Awe	1.87	1	.811
Calmness	2.00	1	1.000
Surprise	2.31	3	.977
Embarrassment	1.15	1	.540
Sadness	2.18	1	1.233
Guilt	1.15	1	.432
Anxiety	1.64	1	.986
Boredom	1.51	1	.756
Valence	4.21	5	1.525
Arousal	5.68	5	1.876
Dominance	5.79	5	1.361

The Emotion Tool emotions were categorised into three groups, depending on which of the three SAM dimensions they better mapped onto. The valence related group included: happiness, boredom, sadness; arousal related group were: excitement, interest, calmness, surprise, fear, anxiety, and dominance related group included: awe, guilt, embarrassment. The categorisation was based on the descriptions of the SAM dimensions [140], as follows:

- Valence – “At one extreme of the happy vs. unhappy scale, you felt happy, pleased, satisfied, contented, hopeful... The other end of the scale is when you felt completely unhappy, annoyed, unsatisfied, melancholic, despaired, bored.”
- Arousal – “At one extreme of the scale you felt stimulated, excited, frenzied, jittery, wide-awake, aroused... you felt completely relaxed, calm, sluggish, dull, sleepy, unaroused.”

- Dominance – “At one end of the scale you have feelings characterized as completely controlled, influenced, cared for, awed, submissive, guided...you felt completely controlling, influential, in control, important, dominant, autonomous.”

The approach for comparing the results of the two instruments was adopted from Bradley and Lang [140] who explored the correlation between two versions of the SAM and semantic differential factors. Hence, here as well, bivariate correlation tests were run between the Emotion Tool emotions and the SAM dimensions. Bonferroni corrections were applied to avoid the multiple comparisons problem, resulting in the $\alpha = 0.05 / (12 \text{ emotions} * 3 \text{ dimensions}) = 0.00139$.

Table A.2 shows the results of the correlation test. Statistically significant correlations exist between: *happiness* and *valence* ($\rho = -.535$, $p = 0.000$), *excitement* and *valence* ($\rho = -.496$, $p = 0.001306$), and *arousal* and *calmness* ($\rho = -.511$, $p = .001042$). Similar results were obtained when applying the Pearson Chi-square test; at the significance level of $\alpha = 0.00139$, the significant relations were:

- interest and valence, $X^2(15) = 48.35$, $p = 0.000$
- *happiness* and *valence*, $X^2(15) = 40.59$, $p = 0.000$
- *boredom* and *valence*, $X^2(15) = 37.74$, $p = 0.000985$
- *guilt* and *dominance*, $X^2(12) = 49.4$, $p = 0.000$.

It should be noted that the negative correlations reflect the inverse scales of the two instruments. The Emotion Tool measures the intensity of emotions on an increasing scale from 1 = not at all to 5 = extremely. The three SAM scales were oriented in an opposite direction – valence starting with 1 = very pleasant to 9 = very unpleasant, arousal starting from 1 = very aroused to 9 = very unaroused, and dominance starting from 1 = very dominated to 9 = very dominant. Thus, the negative correlation between happiness and valence, and excitement and valence is explained. However, arousal and calmness are also negatively correlated, which does not reflect the scales, and implies that as the participants were claiming to feel more unaroused, i.e., calm, on the SAM arousal scale, they were reporting to feel lower intensity of the emotion calmness via the Emotion Tool.

Table A.2. Correlations between SAM dimensions (valence, arousal and dominance) and Emotion Tool emotions (12 emotions)

		Valence	Arousal	Dominance
<i>Valence-related</i>				
Happiness	Correlation Coefficient	-.535**	-.205	.350*
	Sig. (2-tailed)	.000	.216	.029
Boredom	Correlation Coefficient	.403*	.232	-.016
	Sig. (2-tailed)	.011	.160	.925
Sadness	Correlation Coefficient	.190	-.102	-.237
	Sig. (2-tailed)	.247	.544	.146
<i>Arousal-related</i>				
Fear	Correlation Coefficient	.111	-.098	-.241
	Sig. (2-tailed)	.501	.557	.139
Interest	Correlation Coefficient	-.280	-.337*	-.084
	Sig. (2-tailed)	.084	.039	.611
Surprise	Correlation Coefficient	-.218	-.231	.050
	Sig. (2-tailed)	.182	.163	.762
Calmness	Correlation Coefficient	-.376*	-.511**	.164
	Sig. (2-tailed)	.018	.001	.317
Anxiety	Correlation Coefficient	.000	-.283	-.295
	Sig. (2-tailed)	1.000	.086	.068
Excitement	Correlation Coefficient	-.496**	-.325*	.122
	Sig. (2-tailed)	.001	.046	.458
<i>Dominance-related</i>				
Guilt	Correlation Coefficient	-.133	-.166	.488**
	Sig. (2-tailed)	.420	.320	.002
Awe	Correlation Coefficient	.115	-.195	-.123
	Sig. (2-tailed)	.491	.248	.462
Embarrassment	Correlation Coefficient	.118	-.109	-.057
	Sig. (2-tailed)	.473	.515	.729

The found correlations seem to reflect what the SAM scales represent. Interestingly, while the emotion excitement addresses the level of arousal, the results here show it correlated with the SAM's valence scale. Overall, the findings indicate the following relations between the SAM scales and the discrete emotions of the Emotion Tool:

- Emotions *happiness* and *boredom* correlate well with the *pleasant-unpleasant* states.
- Emotion *excitement*, *interest* and *calmness* correlate with the *aroused-unaroused* state.
- And *guilt* is associated with the measure for *dominance*.

Interestingly, dominance also correlates with happiness, the happier the person the more in-control they feel. Moreover, a person in a more pleasant state appears to be experiencing more intensely positive emotions - excitement, interest and calmness. Importantly, *valence*, as a measure of pleasantness and unpleasantness, i.e., positivity or negativity of an affective state, was shown to *negatively correlate with all positive emotions* (apart from awe), and to *correlate positively with the negative emotions* (apart from guilt, as well as surprise which is often classified as a positive emotion).

A.1.2 Test 2: Inter-rater reliability

Additionally, a test of inter-rater reliability was conducted to test the consistency of the emotion intensities reported across the raters, i.e. website users. The approach was adopted from previous studies [352] that collected participant affective states after exposing them to images or English words. Here, users engaged in an experiment with the PORT website, after which they reported their post-use emotions. This was main controlled experiment conducted in Study 4, in which the PORT website with emotion-based personalisation was evaluated.

The dataset contained 107 cases and nine post-use emotions reported on the 5-point intensity scale. All the cases (or raters) which included missing values, i.e., which did not report an intensity for any of the nine emotions, were excluded.

The findings for the interclass correlation (ICC) test, based on average measures, resulted in a coefficient value of .985 ($F(8,848) = 67.3, p = .000$). This indicated a *high inter-rater reliability for the emotions reported after using the website with emotion-based personalisation*.

A.2 Study 5: Emotion Tool reliability analysis

The reliability of the Emotion Tool as an emotion measuring instrument was followed up in Study 5. Two datasets of pre-use emotions were tested. Nine pre-use emotions were explored, and measured on a 5-point intensity scale ranging from 0 to 4. The first dataset was obtained from the Study 5 *usefulness experiment* (see Chapter 4 for methodology and Chapter 7 for the results), in which participants reported their emotions via an online

questionnaire, prior to using the latest version of the PORT website (Phase IV version). The second dataset was obtained from the website log data of emotions reported via the Emotion Tool that appears on the PORT website after a user logs in. The ICC test and Fleiss kappa were applied to both datasets.

Dataset 1 contained emotions reported by 22 users. The results for **Dataset 1** showed a *kappa* value of 0.12, which is below the 0.4 threshold that is considered to be a fair agreement [136]. However, measurement instruments for affect detection in naturalistic context commonly have a *poor* to fair reliability [136]. The ICC findings indicated differently. The *coefficient* value of .95 ($F(8,168) = 20.92, p = .000$) implied a *very high inter-rater reliability* when using the Emotion Tool instrument to report pre-use emotions' intensities.

For **Dataset 2**, only login emotions were considered; emotions reported during website use were not included in this dataset. Moreover, only those users who reported all nine emotions were included in the dataset. The resulting dataset consisted of 12 raters or emotion reports. The findings showed an ICC value of 0.95 ($F(8, 88) = 21.3, p = .000$), further suggesting a *high inter-rater reliability*. However, the *Fleiss kappa* value of 0.33 was still *relatively poor* compared to the threshold scores of 0.6 or above [136].

Appendix B

Survey questionnaire items

Study	Construct (factor)	Questionnaire items	Scale
1	<i>Emotions (For each of the following emotions how likely it is that it would stimulate you to visit and use a health website to search for cancer-related information.)</i>	13 emotions	Rating scale: 1: the most likely – 5: the most unlikely
2	<i>Emotions pre-use (Identifying to which extent you are experiencing each of the following emotions at the moment)</i>	13 emotions	11-point scale: 0: Not experiencing this emotion currently at all – 10: Extremely experiencing this emotion in the current moment.
3		12 emotions	5-point scale: 1: Not experiencing this emotion at all, 2: Mildly, 3: Moderately, 4: Very, 5: Experiencing this emotion extremely
4		9 emotions: <i>Fear, Interest, Sadness, Surprise, Joy, Guilt, Disgust, Shame, Anger</i>	
5			5-point scale: 0: Not at all, 1: Mildly, 2: Moderately, 3: Very, 4: Extremely
2	<i>Emotions post-use (Identify for each of the following emotions to which extent you are currently experiencing it)</i>	13 emotions	11 point-scale: 0: Not experiencing this emotion currently at all – 10: Extremely experiencing this emotion in the current moment.
3		12 emotions	5-point scale: 1: Not experiencing this emotion at all, 2: Mildly, 3: Moderately, 4: Very, 5: Experiencing this emotion extremely
4	<i>Emotions post-use (Please report to which extent you are experiencing each of the following emotions as a result of interacting with this version of PORT website.)</i>	9 emotions: <i>Fear, Interest, Sadness, Surprise, Joy, Guilt, Disgust, Shame, Anger</i>	
Note: Complete list of emotions across studies is provided in Chapter 3.			

1	Personalisation benefits	Do you perceive benefits from having a health website personalised to your needs? (Yes/No)	Dichotomous
1	Availability of personalisation features	For each of the 24 personalisation features	Multiple choice: 1. I use website(s) with this feature. I would prefer to have this feature offered.; 2. I use website(s) with this feature. I would prefer this feature not to be offered.; 3. I do not use website(s) with this feature. I would prefer to have this feature offered.; 3. I do not use website(s) with this feature. I would prefer this feature not to be offered.
2	Usefulness of personalisation features (For each of the following personalisation features available on the second version of PORT's website, rate how useful you found it)		5-point Likert scale: 1: completely not useful - 5: completely useful
3	Usefulness of personalisation features (For a full experience on PORT's website, I perceive as useful the personalisation feature...)	For each of the 33 personalisation features	5-point Likert scale: 1: strongly disagree - 5: strongly agree
4	Usefulness of personalisation features (I found the following personalization features useful when interacting with the PORT website:)	For each of the 32 personalisation features available on the PORT website, e.g.: articles' recommendations, user profile customisation, content recommendations on user profile matched to user emotions, etc.	5-point Likert scale: 1: strongly disagree - 5: strongly agree; Additional option 6: I did not notice this feature of the website.
5	Usefulness of personalisation features (Evaluate the usefulness of this feature/content on the PORT cancer website:)	Each of the 42 features. (NOTE: Not part of the factor usefulness of personalisation features, ten other features and content types were evaluated for their usefulness, including: articles, KB, forum and blog content, creating blogs, privacy policy, search functions,	5-point scale: -2: very useless to 2: very useful.

		forum and blog search, and categories of content)	
<i>Note: Detailed list of personalisation features explored across the five studies is in Appendix C.</i>			
1	Approach to providing personalisation features	24 features	Dichotomous: 1. I am enabled to choose whether or not to use this feature; 2. The system automatically chooses for me
3	Preference for adaptivity vs. adaptability	I prefer to be enabled to choose whether or not to be offered a specific website feature.	Dichotomous: Yes, No
		I prefer to customise the website myself.	
		I prefer the system to tailor its features automatically.	
		I prefer to select all my interests within my profile.	
		I prefer the system to infer my interests based on my behaviour on the website.	
4	Usefulness of adaptivity	12 PORT website features that represent adaptive services, e.g.: <i>website automatically creating content recommendations, automatically highlighting or hiding website features</i> , etc. (listed in Chapter 7, Section 7.1.2).	5-point Likert scale: 1: strongly disagree to 5: strongly agree
4	Usefulness of adaptability	16 PORT website features that are adaptable services, e.g.: <i>giving feedback about the usefulness of recommendations, defining personal interests</i> , etc. (listed in Chapter 7, Section 7.1.2).	
3	Satisfaction with website personalisation (I am satisfied with how the PORT website was personalised to my needs because it...)	... knew what I wanted	
		... took into consideration my interests and preferences to make recommendations to me	
		... improved my search performance	
		... provided valuable content to me	
		... provided relevant content to me	
		... provided content at the right level of detail	
		... provided up-to-date content to me	
		... could save me time	
4	Satisfaction with website personalisation	I am satisfied with the interface and appearance	
		I am satisfied with the ease with which I can find desired content	
		I felt I was provided with relevant content and features, tailored to my interests or preferences	
		I felt the website knew what content and features satisfy my emotions	

		Overall, I am satisfied with this version of PORT's website	
2, 3		I intend to revisit the website.	
		I intend to use the website frequently.	
2, 3, 4	Reuse intentions	(Given the chance,) I intend to use the website (/this version of PORT website) again.	
		I would recommend the website (/this version of PORT website) to my friends.	
		Overall, I have a positive attitude towards using the website (/this version of PORT website).	
<i>Note: In measuring Reuse intentions, Study 2 referred to 'the 2nd version of PORT website', Study 3 to 'the website', Study 4 to 'this version of PORT website'.</i>			
2		I think I would rather like to use again the 2nd version of PORT's website than the 1st version	
		The 2nd version of PORT's website had more functions and capabilities I expected in this type of website compared to those provided in the 1st version	
3		The interface of PORT's website was pleasant	
		PORT's website had the features and capabilities I expected in this type of websites	
2, 3	Website usability	I found (2nd version of PORT's website compared to the 1st version more / PORT's website) complex for usage	
		I thought PORT's website was ineffective and inefficient in enabling me to complete various tasks	
		It would be easy for me to learn to use PORT's website	
		I did not feel confident using PORT's website	
		Overall, I was satisfied with PORT's website	
4, 5		SUS1: I think that I would like to use this version of PORT's website frequently	
		SUS2: I found this version of PORT's website unnecessarily complex	
		SUS3: I thought this version of PORT's website was easy to use	
		SUS4: I think that I would need the support of a technical person to be able to use this version of PORT's website	
		SUS5: I found the various functions in this version of PORT's website were well integrated	
		SUS6: I thought there was too much	

5-point Likert scale: 1: strongly disagree to 5: strongly agree

		inconsistency in this version of PORT’s website	
		SUS7: I think that most people would learn to use this version of PORT’s website very quickly	
		SUS8: I found this version of PORT’s website very complicated to use	
		SUS9: I felt very confident using this version of PORT’s website	
		SUS10: I needed to learn a lot of things before I could get going with this version of PORT’s website	
5	Preference for website version (<i>In your opinion, which of the two versions of the PORT cancer website has more appropriate personalisation services?</i>)	I prefer Version P to Version E	Multiple choice
		I prefer Version E to Version P	
		I prefer both versions equally	
		I do not prefer either of the two versions; both are equally unpreferred	
<i>Note: In measuring Usability - in Study 2 the 2nd version (personalised website) was compared to the 1st version (original Wordpress website) the wording used was '2nd version compared to the 1st version'; in Study 3 the wording was 'PORT's website'; in Study 4 and 5 the wording was 'this version of PORT's website'</i>			
1, 2, 3, 4, 5	Demographic data	Age	Demographic question; textbox to type in a response
3, 4, 5		Country of residence	Demographic question; textbox to type in a response
1, 2, 3, 4, 5		Gender: Female, Male, (Study 4, 5: Other)	Multiple choice
1, 2		Level of education	Multiple choice
		a. None	
		b. Elementary school	
		c. High school graduate	
		d. Undergraduate degree	
		e. Master degree	
		f. PhD	
	g. Other		
2, 3, 4, 5		How cancer affected the person's life: Please select the most appropriate category for yourself:	Multiple choice
		a. I am a current or former cancer patient.	
		b. My family member(s) have (or had) cancer, or has passed away due to cancer.	
		c. My friend has (or had) cancer, or has	

		passed away due to cancer.	
		d. I am a caregiver of one/more cancer patient(s).	
		e. Neither I nor any of the people close to me are affected by cancer. I am simply interested in cancer-related information.	
		f. None of the above.	
2, 3, 4, 5	<i>Feedback</i>	Please provide in the space below any further comments, remarks, complaints or suggestions you have with regard to your experience in using PORT Association's health website.	Open-ended

Appendix C

Descriptive statistics for usefulness of website features evaluated in Study 2 - Study 5

Note, in Study 2 - Study 5 a 5-point Likert scale was used. In Study 1, this was a multiple choice question with the following options: 1. I use websites with this feature and would prefer to have the feature offered.; 2. I use these websites, but would prefer not to have the feature offered.; 3. I do not use, but would prefer to have offered.; 4. I do not use, and would prefer not offered.

Personalisation features	Study 5			Study 4			Study 3			Study 2			Study 1
	Mean	Median	SD	Mean	Median	SD	Mean	Median	SD	Mean	Median	SD	Mode*
Bilingual content - language selection	4.6	5.0	0.7	4.0	4.0	1.1	4.0	4.0	1.0	4.1	4.0	0.9	3
Private messaging a psychologist	4.3	5.0	1.3										
Privacy policy presentation – choosing between long and concise version	4.3	5.0	0.9	3.4	3.0	1.1	3.8	4.0	0.9				
Filtering content by cancer type	4.5	4.5	0.5										
Information bubbles about each data field in profile editing	4.3	4.5	0.8	3.5	4.0	0.9	3.9	4.0	0.8				
Filtering search by content type	4.3	4.0	0.7										
“Is this a useful recommendation for you?” - feedback upon opening a recommendation	4.3	4.0	0.5										
Filtering/sorting recommended content on user's profile (date, best match, language, and other criteria)	4.3	4.0	0.8	3.5	4.0	1.1	3.9	4.0	0.8				

Articles recommendations (on the Articles main page and an article's page)	4.2	4.0	0.4	3.6	4.0	1.0	4.0	4.0	0.8	3.9	4.0	0.9	
Adaptive storyline – Recommending similar content to the one a user selected was useful	4.2	4.0	0.7	3.7	4.0	1.1							
"Why recommended?" - explanation why a recommendation was given	4.2	4.0	0.4										
User profile content - having in one place content recommendations, personal activities, blogs and readlists	4.2	4.0	0.6										
Personal readlist (i.e., add to readlist, bookmarks)	4.1	4.0	0.8	3.5	4.0	1.2	3.9	4.0	0.7	3.9	4.0	1.1	
Recommendations of content reflecting user interests and content preferences (Recommendations on user's profile matched to: content previously read and preferred (rating); personal interests)	4.1	4.0	0.7				3.9	4.0	0.9				
"Is this a useful recommendation?" - Giving feedback (selecting Yes/No) about the usefulness of recommendations and if user's personal data (basic information and interests) should be used in generating the recommendations	4.1	4.0	0.8	3.7	4.0	1.1							
Filtering search by other criteria (date, title, popularity, etc.)	4.1	4.0	0.7										
Blog recommendations (on the Blogs main page and a blog's page)	4.1	4.0	0.6	3.5	4.0	1.0	3.9	4.0	0.8	3.4	4.0	1.1	3
Defining personal interests for the website profile	4.1	4.0	1.1	3.7	4.0	0.9	4.1	4.0	0.8				
Recommendations of content (on user's profile)	4.1	4.0	1.0	3.6	4.0	1.0							
Rating website's content	4.0	4.0	0.6	3.7	4.0	1.0	4.0	4.0	0.9	3.4	4.0	1.3	

Knowledge base recommendations (on the Knowledge base main page and a knowledge base article's page)	4.0	4.0	0.6	3.5	4.0	1.1	4.1	4.0	0.7				
Sharing website's content	4.0	4.0	0.6	3.5	4.0	1.1	3.8	4.0	0.9	3.7	4.0	1.1	
Readlist content - viewing and filtering	4.0	4.0	0.7										
Recommendations of content reflecting user interests, content preferences, and matching user emotions (Study 4: The website automatically creating content recommendations for the user (based on user interests, ratings, emotions, and other behaviour on the website))	3.9	4.0	0.7	3.5	4.0	1.0							
Notifications - Orange triangle and bell icon notifying the user data is missing in their profile	3.9	4.0	0.7	3.6	4.0	1.0							
If a user did not find a recommendation useful, removing it from future content recommendations	3.9	4.0	0.7										
Commenting on website's content	3.8	4.0	0.9	3.6	4.0	1.1	3.9	4.0	0.9	3.7	4.0	1.2	
User profile customisation	3.8	4.0	0.7	3.6	4.0	1.0	3.9	4.0	0.9	3.5	4.0	1.2	3
Highlighting or hiding content or features - as a result of emotions reported, to respond to the needs of user's affective state (Study 4: directing the user to specific website parts based on their emotions)	3.8	4.0	0.9	3.4	4.0	1.1							
Hiding features/content - directing the user away from specific website parts based on their emotions	3.8	4.0	0.7										
Chatroom	3.8	4.0	1.3	3.4	3.0	1.2	3.8	4.0	0.9				
Reporting emotions on a cancer website	3.7	4.0	1.0										

Emotion tool (Study 5: Emotion tool appearance – emotions, scales and emoticons used to report affective state)	3.7	4.0	0.9	3.8	4.0	1.1	3.4	4.0	1.2				
Reporting emotions at rating	3.6	4.0	1.1										
Forum discussions recommendations (on the Forum main page)	3.6	4.0	1.1	3.6	4.0	1.0	3.8	4.0	0.9	3.6	4.0	1.1	3
Notifications - Red rectangle within user profile notifying profile data is not complete	3.5	4.0	0.9	3.5	4.0	1.0							
Highlighting features/content - directing the user to specific website parts based on their emotions	3.5	4.0	0.8										
“What did you think about the following content?” – reminding the user to rate a content	3.5	4.0	1.1	3.6	4.0	1.0	3.7	4.0	1.0				
Adapting text size	3.5	3.5	0.8	3.7	4.0	1.0	4.0	4.0	1.0	3.5	4.0	1.2	
Adapting text colour	3.4	3.5	1.2	3.6	4.0	1.1	3.6	4.0	1.1	3.0	3.0	1.4	
Greeting the user with their name	3.5	3.0	0.9	3.9	4.0	1.0	3.6	4.0	0.9	3.1	3.0	1.3	3
Tailoring website background (colour/image)	3.2	3.0	0.6	3.4	4.0	1.1	3.3	3.0	1.0	2.7	3.0	1.2	
Enabling the user to personally customise the website by updating their preferences and personal data				3.7	4.0	1.0							
The website automatically highlighting or hiding features from the user (based on user emotions)				3.6	4.0	1.0							
In profile editing, enabling the user to state for every personal data type whether they want it to be used in tailoring the content recommendations				3.5	4.0	1.0							
Filtering search outcomes				3.5	4.0	1.1	4.0	4.0	0.9				
Search outcomes presentation							3.9	4.0	0.7	3.8	4.0	1.1	

Appendix D

Experiment tasks

Appendix D provides a detailed list of tasks prescribed in the experiments performed in Study 2 – Study 5.

D.1 Study 2 experiment tasks

The *experiment instructions were the same for both websites* (unless otherwise noted), and included:

1. Visit **version 1** of PORT website at <http://www.port.org.ba/>¹⁶ / Visit **version 2** of PORT website at http://port.website.ba/web/app_dev.php¹⁷
2. Register on the website
3. Read the privacy policy and terms of use
4. Edit your profile
5. Use the search to find a cancer-related term of interest to you
6. Read an article, and use any of the website functions available while reading the article
7. Use the virtual community
 - a. **Version 1 instruction:** Join a group most relevant to you / **Version 2 instruction:** Read a blog post or create your own blog
 - b. Read, start, comment or rate a forum discussion
8. Review the activities listed on your profile.

D.2 Study 3 experiment tasks

¹⁶ Version 1: The link to the original Wordpress version of the website was <http://www.port.org.ba/>. The domain is now used for the latest version of the personalised PORT website. The original website is not in use anymore.

¹⁷ Version 2: This was a prototype website developed for this research - port.website.ba/web/app_dev.php. It is not functional any longer.

The *tasks* prescribed in the Study 3 experiment are presented here. All the tasks refer to CG1. CG2 tasks are clearly labelled.

1. Visit PORT's website at <http://new.port.org.ba> (CG1 and CG2)
2. CG1: Create an account on the website. / CG2: *If at any step while using the website you are asked to create an account prior to using the specific website service, PLEASE DO NOT CREATE AN ACCOUNT, and continue using the website without logging in, because we want to measure your experience on the non-personalised/default website.*
3. Use the Emotion Tool¹⁸.
4. Read the privacy policy (CG1 and CG2)
5. Edit your profile
 - a. Fill in your profile in detail
 - i. For each data field answer whether it is of interest to you to be provided personalisation based on the particular data
 - b. Use the Emotion Tool
6. Use the search to find a cancer-related term of interest to you (CG1 and CG2)
 - a. Read an article from the search outcomes (CG1 and CG2)
 - i. Use all of the website functions available while reading the article (CG1 and CG2)
 - ii. Use the Emotion Tool
7. Go to the Articles link in the main menu (CG1 and CG2)
 - a. CG1: Articles recommended to you / CG2: *Select and view one of the recommended articles*
 - i. Answer whether you perceive the recommendations are useful to you
8. Use the virtual community (CG1 and CG2)
 - a. Create your own blog, and add at least one blog post to it
 - b. Go to the main page for blogs (CG1 and CG2)
 - i. Answer whether you perceive the recommendations are useful to you

¹⁸ On Phase II PORT website, the Emotion Tool did not pop-up automatically, but was present in the bottom left corner of all web pages, and expanded to full view on hovering over it.

- ii. CG1: Read and rate a post from a blog of interest to you / *CG2: View one of the recommended blogs or search for a blog of interest to you*
 - iii. Use the Emotion Tool
 - c. Go to the Forum (*CG1 and CG2*)
 - i. Select a forum category of interest to you (*CG1 and CG2*)
 - ii. CG1: If there are existing discussions, view them and provide a comment. If not start your own forum discussion relevant to the forum category you are in. / *CG2: View a forum discussion.*
- 9. Go to the Knowledge Base link in the main menu (*CG1 and CG2*)
 - a. CG1: Answer whether you perceive the recommendations are useful to you / *CG2: Select and view Knowledge Base articles recommended to you*
 - i. Use the Emotion Tool
- 10. Go to your profile in My PORT tab.
 - a. Rate any content you have viewed but have not rated by using the “What did you think about the following content?” feature
- 11. To view the changes in the recommendations made to you on the website, log-out and then log into the website again.
- 12. Go to your profile in My PORT tab
 - a. View the recommended content
 - b. For at least 3 recommendations, answer whether you perceive the recommendations are useful to you
 - c. Select one recommendation to view
 - d. Use the Emotion Tool
- 13. Taking the role of a person affected by cancer who is visiting this website to search for a specific type of content and support: (*CG1 and CG2*)
 - a. Go to the web page you would start your visit from (*CG1 and CG2*)
 - i. And use the Emotion Tool to express your emotions
 - b. Perform at least 3 steps (views) on the website that would be of interest to you in such a situation (*CG1 and CG2*)
 - c. Use the Emotion Tool to express your emotions at the last web page you were on.

D.3 Study 4 experiment tasks

The following list presents the *tasks* prescribed in the Study 4 experiment. The website label in front of each task indicates which website version the task was instructed for.

1. **DEF, PRE, EXT**: Go to <http://dev.port.org.ba/>. (*this link was given for DEF and EXT, while for PRE it was <http://new.port.org.ba/>*)
2. **DEF, PRE, EXT**: At the top right corner of the website, select the language of your preference - English or Bosnian.
3. **PRE, EXT**: Register to the website via the Create Account button. You will have to register to each website version individually; however you can use the same account details (e-mail, username and password). If you already have an account on this website version, please go to task 4.
4. **PRE, EXT**: Log into the website with the registered details. / **DEF**: *Note, please DO NOT log into the website. The aim is for you to experience the website without creating an account and providing your details. If you are logged in, please log out.*
5. **PRE, EXT**: Record your emotions at the start of website usage
 - a. **EXT**: Use the Emotion Tool presented in the pop-out window after logging into the website. / **PRE**: *Use the Emotion Tool, which is the yellow square in the bottom right hand corner of the website.*
6. **PRE, EXT**: Please use the website for at least ten **(10) minutes**... / **DEF**: *Please use the website for at least **five (5) minutes**.../ ... following this scenario:*
 - a. Take the role of a person who is affected by cancer – directly, indirectly via a family member or a friend, or someone seeking for prevention information.
 - b. Determine which type of cancer, or cancer related problem, you are hypothetically concerned about.
 - c. Assume you came to this website to inform yourself about that specific cancer type/cancer problem.

- d. Go to the web pages, explore the content and features, you would in such circumstances.
 - e. Pay attention to: distinctive features on this website version, using as many features available as possible, reporting your emotions via the Emotion Tool as frequently as possible.
7. **PRE, EXT:** Log out of the website.
 8. **DEF, PRE, EXT:** Now assume the following scenario:

Taking the role of the same cancer-affected person as in the above scenario, presume you visited a doctor a few days later. The doctor told you about the treatment that should be applied for the specific cancer type/cancer-related problem that is affecting you.

However, you would like to inform yourself more about the treatment options, for the purpose of which you visit the PORT website, and do the following:

9. **PRE, EXT:** Log back into the website.
10. **PRE, EXT:** Record your emotions – use the Emotion Tool (**EXT**:...*presented in the pop-out window after logging into the website*).
11. **DEF, PRE, EXT:** Use the website for approx. *5 minutes*, to inform yourself about the treatment options.
 - a. **PRE, EXT:** Pay attention to your Profile segment of the website (within My PORT tab).

D.4 Study 5 experiments

D.4.1 Study 5: Experiment 2 tasks

The *second experiment* in Study 5 was based entirely on tracking **user interactions** with the latest version of the PORT website. The tasks were as follows:

1. Go to <http://www.port.org.ba/>.

2. At the top right corner of the website, *select the language* of your preference - English or Bosnian.
3. Use the following account to *log into the website*: *username: guest, password: 321*
4. If you wish you can *edit the profile information* (it will initially be blank or with default data).
5. *Record your emotions* at the start of website usage – use the Emotion Tool presented in the pop-out window after logging into the website.
6. Please *use the website for at least **five (5) minutes**, following this scenario*:
 - b. Take the *role of a person who is affected by cancer* – directly, indirectly via a family member or a friend, or someone seeking prevention information.
 - c. Determine which type of cancer, or cancer related problem, you are hypothetically concerned about.
 - d. Assume you came to this website to inform yourself about that specific cancer type/cancer problem.
 - e. Go to the web pages, explore the features and content, you would in such circumstances.

D.4.2 Study 5: Experiment 3 tasks

The following is the list of tasks prescribed to participants in Experiment 3:

1. **E:** Go to <http://www.port.org.ba/>. (Note: You can select English for the language of the website at the top right-hand corner of the website.) / **P:** Go to <http://new.port.org.ba/>.
2. **E:** If you do not already have an account, please create an account on this website. Log in with the registered details. / **P:** *This is another version of the PORT website. Unless you already have an account on <http://new.port.org.ba/>, please create an account now. You can use the same account details as for the previous website version. Log in with the registered details.*

3. **E:** An Emotion Tool should pop-out at login, but DO NOT report your emotions. CLOSE the Emotion Tool.
4. **E, P:** Find the following article by entering the title in the website's search tool (copy/paste):
 - a. **E, P:** "Don't believe the hype – 10 persistent cancer myths debunked"
5. **E, P:** Open the article and scan its content.
 - a. **E, P:** Rate the content. Give a high rating, more than 3 stars. (Note: High rating indicates a content is liked; hence, similar content will be recommended in future visits to the website.)
 - b. **E:** The Emotion Tool will pop-out at rating:
 - i. **E:** Report *only* to which extent you are experiencing the emotion **interest**.
6. **E, P:** Visit your Profile page - click on My PORT (top right-hand side of the website).
 - a. **E, P:** Scroll through the Profile page.
 - b. **E, P:** Find the subtitle '*Recommended content*'.
 - i. **E, P:** Below it is a list of personalised content recommendations.
 - ii. **E, P:** Scroll through the list of titles that are recommended to you.
7. **E, P:** Log out.
8. **E, P:** Log back in with the same account.
9. **E:** When the Emotion Tool pops-out at login, *report only* the intensity for **interest**.
10. **E, P:** Observe any changes that occurred in the appearance of the website.
11. **E, P:** Go to your Profile page (My PORT).
 - a. **E, P:** Scroll through the page, and observe any changes in the content.
 - b. **E, P:** Pay particular attention to the list of recommendations under the 'Recommended content'.

Appendix E

Personalisation features available on the PORT website

This section presents the characteristic features available on the latest (Phase IV) version of the PORT website. The *figures of features* are labelled with: *feature name*, as used in this research and *sequence of links* to follow on the website to reach the feature. The feature itself is encircled in red in the screenshot.

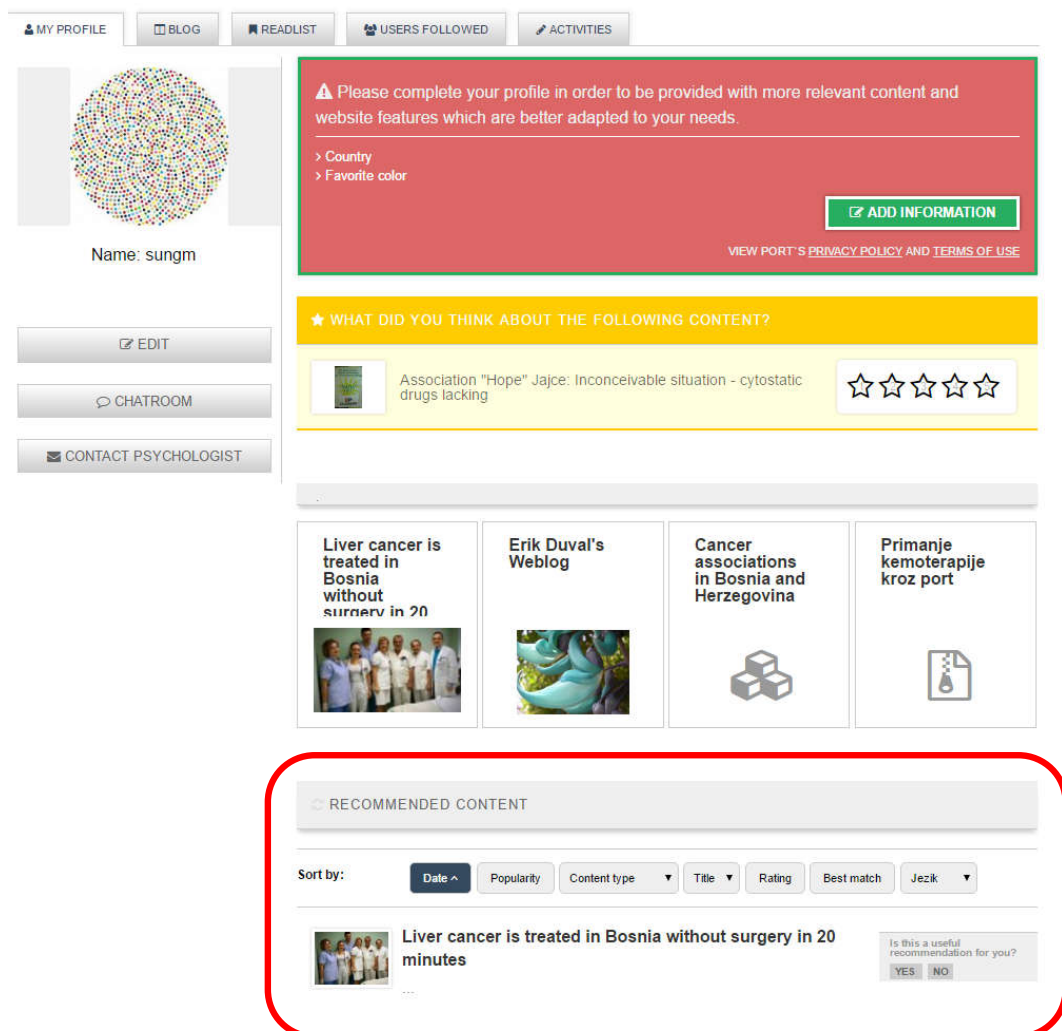


Figure A.2. *Content recommendations on the user profile page* (MyPORT – Profile – My Profile - Recommended content)



Figure A.3. *Why recommended?* (MyPORT – Profile – My Profile - Recommended content – Why recommended? Also on the main page of every content type (Articles, KB, Forum, Blogs), next to the recommendations on the top of the page.)

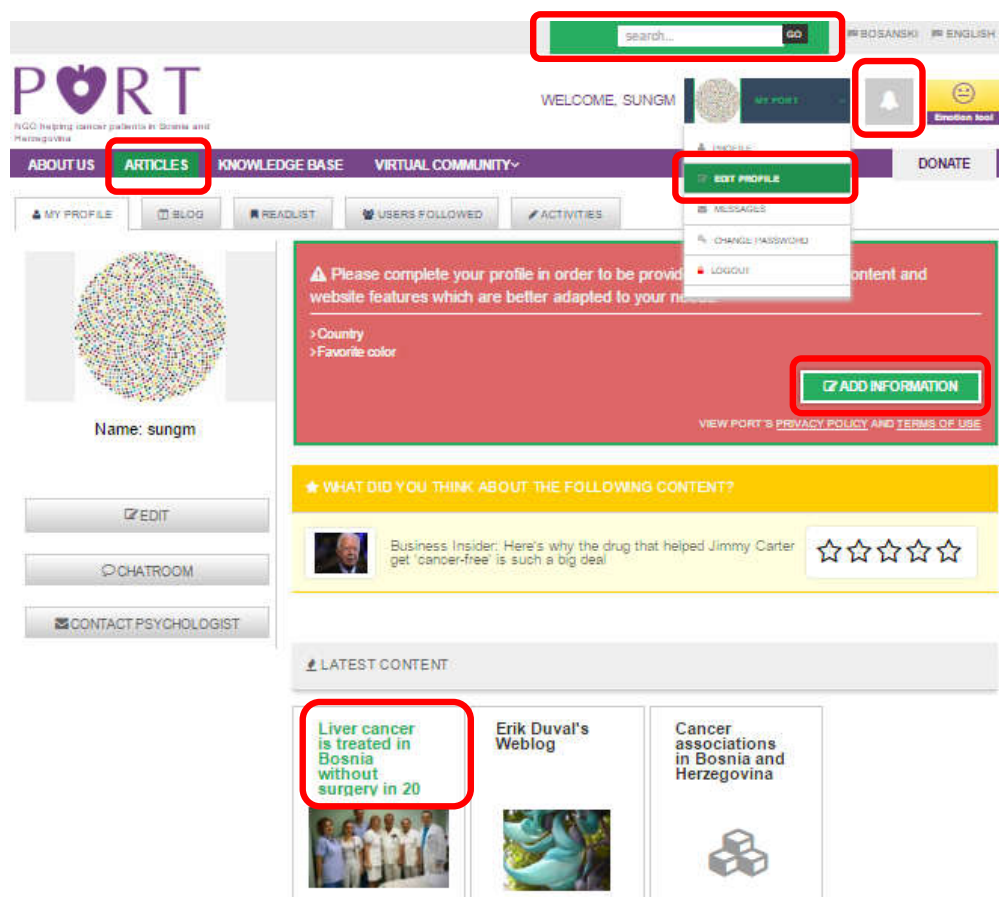


Figure A.4. *Highlighting or hiding features/content based on their emotions* (Different parts of the website; e.g., highlighted (in green) are: Articles, Edit Profile and search tool; hidden is: orange triangle from the Notifications bell.)

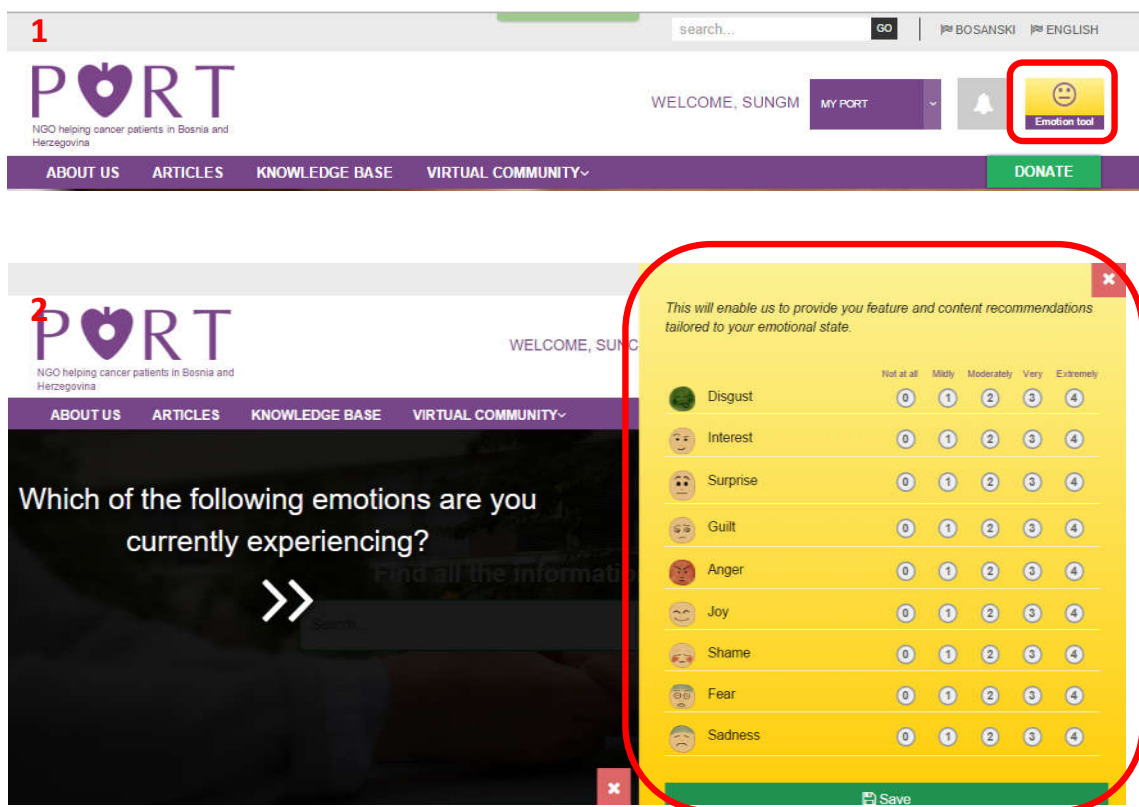


Figure A.5. Emotion Tool (1. Icon, in the top right hand corner of the website; 2. Expanded form – opens at login, or when clicking on the icon)

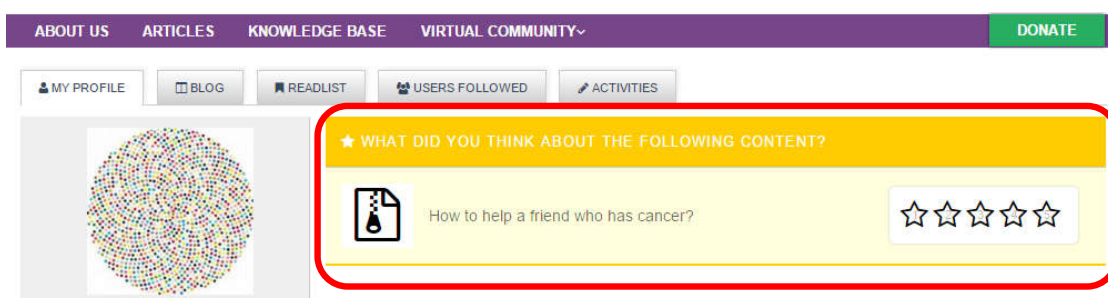


Figure A.6. What did you think about the following content? (The features that reminds the user to rate a content. MyPORT – Profile – My Profile - What did you think about the following content?)

ABOUT US ARTICLES KNOWLEDGE BASE VIRTUAL COMMUNITY~ DONATE

BASIC INFORMATION

*Gender Female

*Date of birth Dec 19 1985

Name:

Surname:

*Make your name and surname public? No

Country:

Canton:

*Email: s.hadzidedic@warwick.ac.uk

Favorite color:

INTERESTS

+ How have you been affected by cancer? Are you: CHECK ALL

+ Type of cancer you are interested in, categorized by gender CHECK ALL

+ Cancer types you are interested in reading about on this website CHECK ALL

+ Type of cancer-related information you would like to have offered on this website CHECK ALL

I accept PORT's [Terms of Use](#) and [Privacy Policy](#)

SAVE CHANGES

Profile picture:

Choose File No file chosen

Background image:

Choose File No file chosen

I want the default website background

Figure A.7. User profile customisation (Accessing, viewing and editing user data via MyPORT – Edit Profile)

BASIC INFORMATION

*Gender Female

*Date of birth Dec 19

Name:

This piece of data will be required for creating an account on PORT's website. It will be used as a criterium for recommending the content which is the most relevant to you. Your gender will not be visible or accessible to other users of this website.

Figure A.8. Information bubbles about each data field in profile editing (MyPORT – Edit Profile)

ABOUT US ARTICLES KNOWLEDGE BASE VIRTUAL COMMUNITY

INTERESTS

How have you been affected by cancer? Are you: ☒ CHECK ALL

a cancer sufferer ☒ a family member or a friend of a person who has or had cancer ☒

not necessarily affected by cancer directly or indirectly, but interested in cancer-related information ☒

Type of cancer you are interested in, categorized by gender ☒ CHECK ALL

Men's cancers ☒ Women's cancers ☒

Cancer types you are interested in reading about on this website ☒ CHECK ALL

Type of cancer-related information you would like to have offered on this website ☒ CHECK ALL

Figure A.9. Defining personal interests for the website profile (MyPORT – Edit profile – Interests)

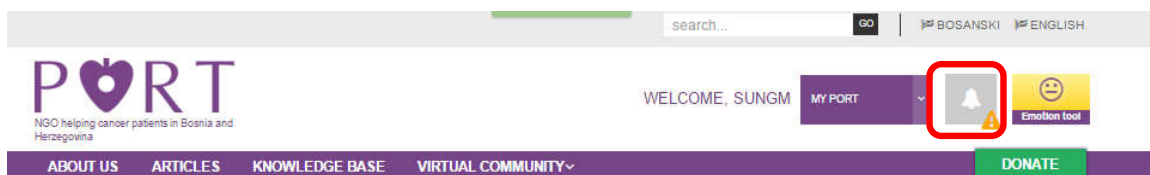


Figure A.10. Orange triangle with a Notifications bell (An icon notifying the user data is missing in their profile; Top right-hand corner of the website)

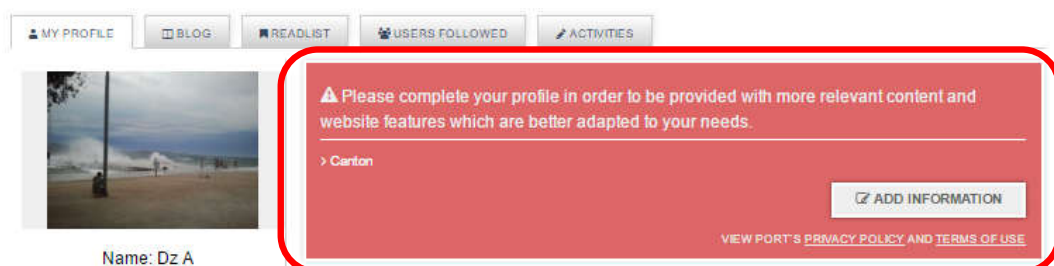


Figure A.11. Red rectangle within user profile (A feature notifying the user data is missing in their profile; MyPORT – Profile – My Profile)

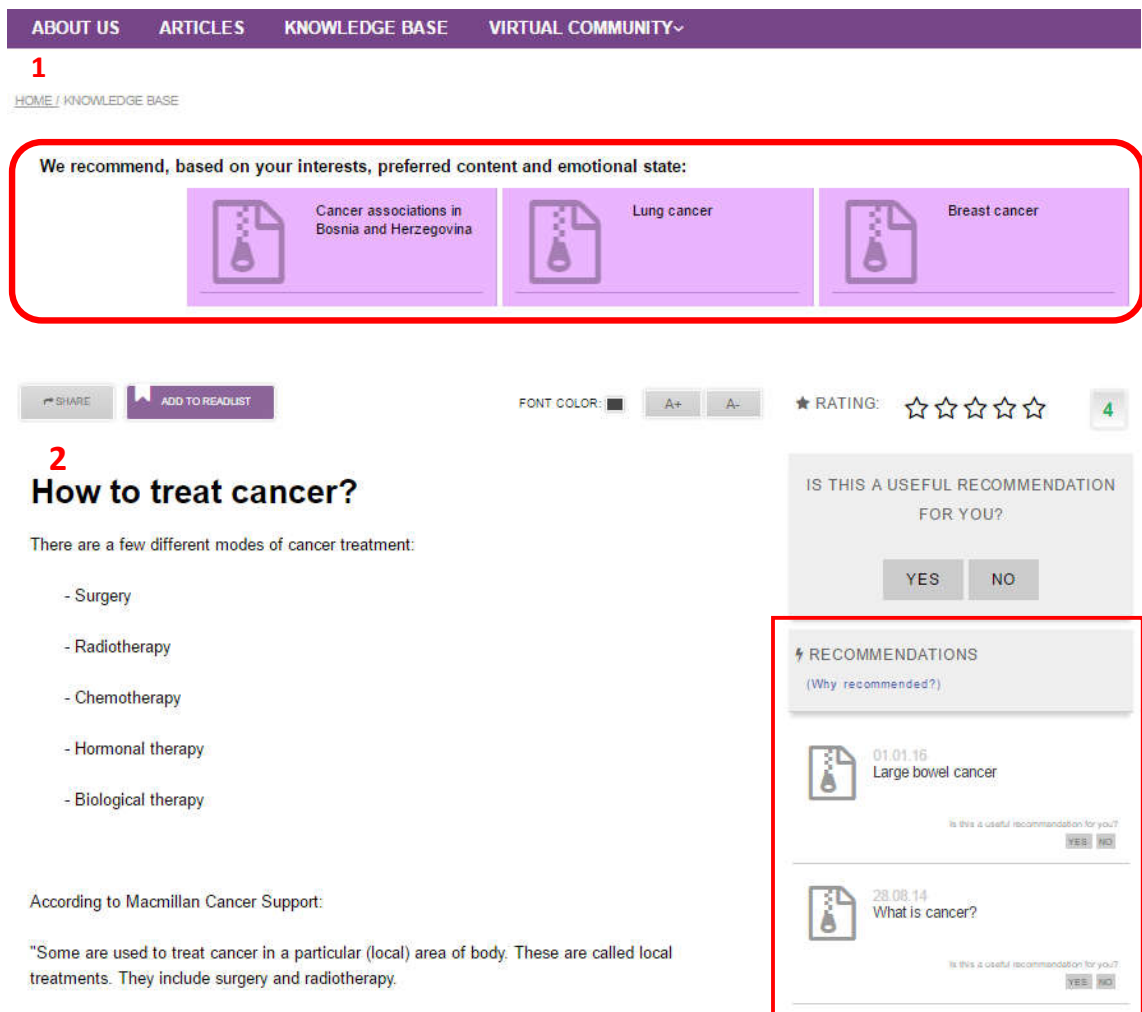






Figure A.12. Knowledge base recommendations (On 1. the Knowledge base main page and 2. a knowledge base article's page)

We recommend, based on your interests, preferred content and emotional state: (Why recommended?)


 <p>Swab test to detect three types of cancer</p> <p>Is this a useful recommendation for you?</p> <p>YES NO</p>	 <p>Business Insider: Here's why the drug that helped Jimmy Carter get 'cancer-free' is such a big deal</p> <p>Is this a useful recommendation for you?</p> <p>YES NO</p>	 <p>Prof Dr Borislav Stijelja talks about prostate cancer</p> <p>Is this a useful recommendation for you?</p> <p>YES NO</p>	 <p>It's possible to beat cancer</p> <p>Is this a useful recommendation for you?</p> <p>YES NO</p>
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ABOUT US ARTICLES KNOWLEDGE BASE VIRTUAL COMMUNITY DONATE

REMOVE FROM READLIST FONT COLOR: A+ A- ★ RATING: 4.3

08.07.14 / 15:54 Author: nadja

American scientists claim: Fasting helps cure cancer



The most recent study conducted by a group of American professors showed that fasting rebuilds the entire immune system and helps cancer patients.

While most nutritionists opposed to this idea, medical experts believe that even a short fast for a period of three days can have great benefits for human immunity because, as they say, renews and strengthens. Scientists in the United States (US) have this scientific discovery called "extraordinary".

RECOMMENDATIONS

- 04.02.13 Beetroot - the miracle queen from the ground
Is this a useful recommendation for you?
YES NO
- 09.08.13 Balkan Health Forum
Is this a useful recommendation for you?
YES NO
- 22.01.13 Aspartame - the most dangerous sweetener of the
Is this a useful recommendation for you?
YES NO
- 07.10.13 Fennel oil
Is this a useful recommendation for you?
YES NO

Figure A.13. Article recommendations (On 1. the Articles main page and 2. an article's page)

We recommend, based on your interests, preferred content and emotional state: (Why recommended?)

 <p>Research</p> <p>Is this a useful recommendation for you?</p> <p>YES NO</p>	 <p>Cancer types</p> <p>Is this a useful recommendation for you?</p> <p>YES NO</p>	 <p>Presents and gifts</p> <p>Is this a useful recommendation for you?</p> <p>YES NO</p>	 <p>Jokes</p> <p>Is this a useful recommendation for you?</p> <p>YES NO</p>
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Figure A.14. Forum discussions recommendations (On the Forum main page; Virtual community – Forum – top of the Forum main page)



Figure A.15. Blogs recommendations (On the Blogs main page and a blog’s page;
Virtual community – Blogs (or select a blog from the list))



Figure A.16. Privacy policy presentation (Choosing between long and concise version;
Privacy policy – Or view the concise version)

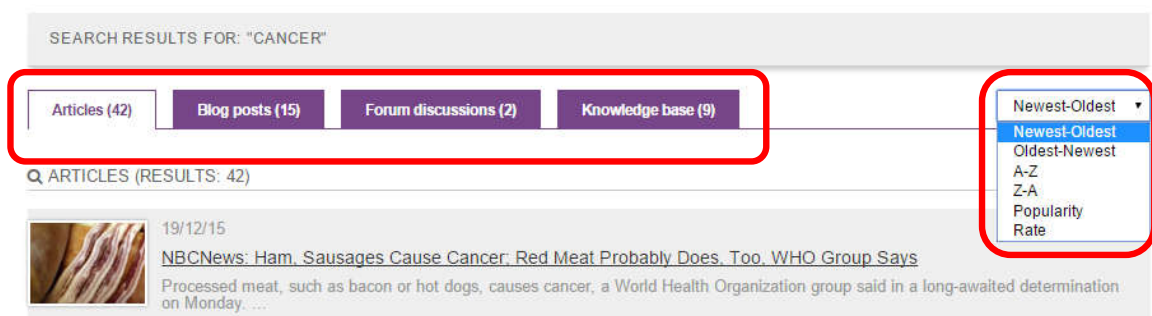


Figure A.17. Filtering search outcomes (Search – Filter – Filter by content type (top)
and other parameters (right))

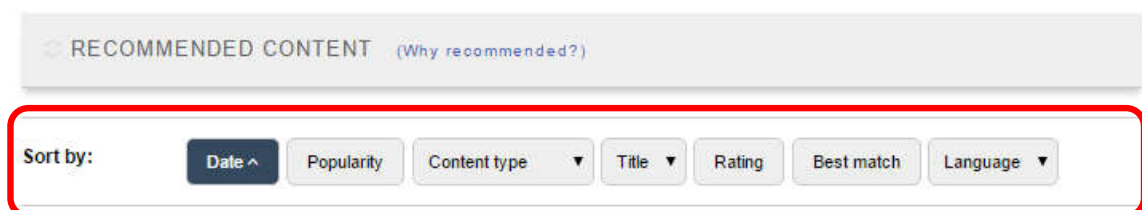


Figure A.18. Filtering recommended content on user profile page (MyPORT – Profile
– My Profile – Sort by: Date, Popularity, Content type, Content title, Content rating, Best
match to user preferences, Language)



Figure A.19. Adapting text size (When viewing specific content, e.g., an article – the buttons for font size A+ and A-)



Figure A.20. Adapting text colour (When viewing specific content, e.g., Articles – the button Font colour)



Figure A.21. Sharing website's content (When viewing specific content (an article, knowledge base article, blog post, forum discussion) - Share button)

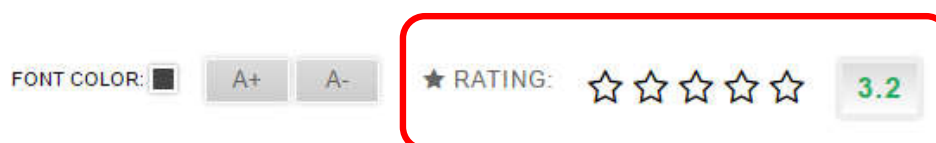


Figure A.22. Rating website content (When viewing a content (e.g. article) - Rating stars)

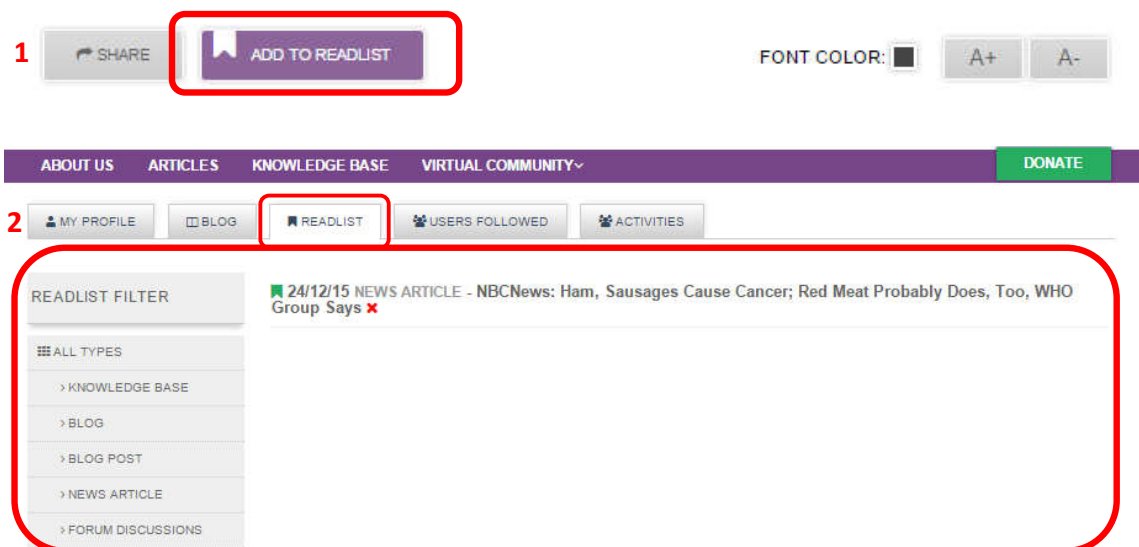


Figure A.23. Personal readlist (1. When viewing specific content (an article, knowledge base article, blogpost, forum discussion) – Add to readlist; 2. MyPORT – Profile – Readlist)

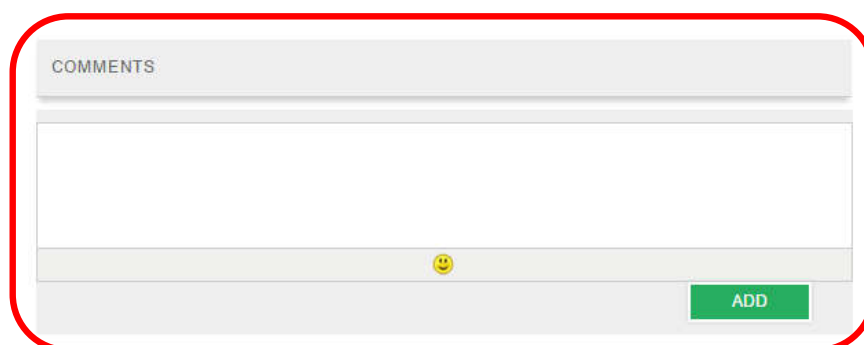


Figure A.24. Commenting on website's content (Within an article or a blog post – at the bottom of the content)

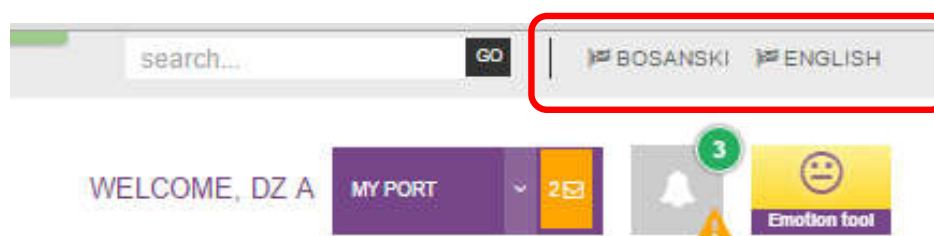


Figure A.25. Bilingual content (Website content in user's native language; throughout the website – top right hand corner)

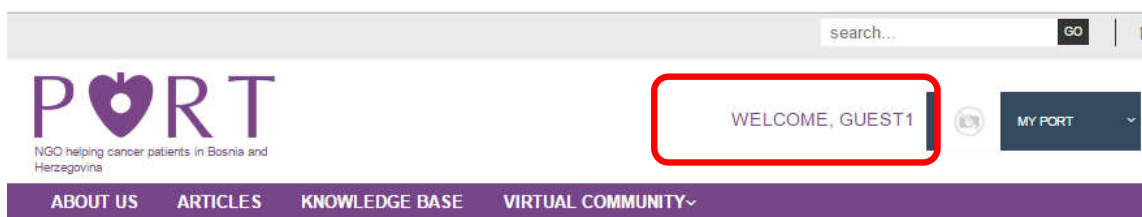


Figure A.26. Greeting the user with their name (Throughout the website – above the main menu)

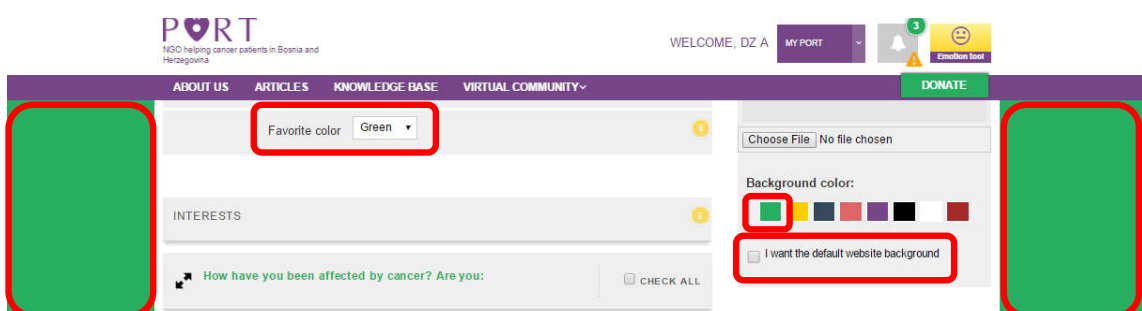


Figure A.27. Tailoring website background colour (MyPORT – Edit Profile - selecting Favourite colour, Background colour or the checkbox ‘I want the default website background’)

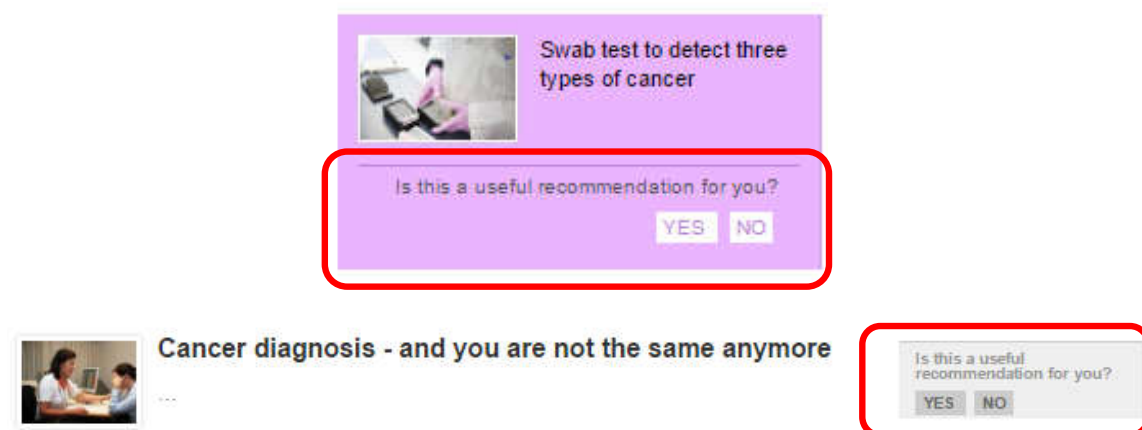


Figure A.28. Is this a useful recommendation? (Giving feedback about the usefulness of recommendations. Throughout the website where there are content recommendations, and on MyPORT – Edit Profile. Refer to the features: Adaptive storyline – Recommending similar content to the one a user selected was useful, and “Is this a useful recommendation for you?” – for every recommendation asking user feedback about its usefulness)

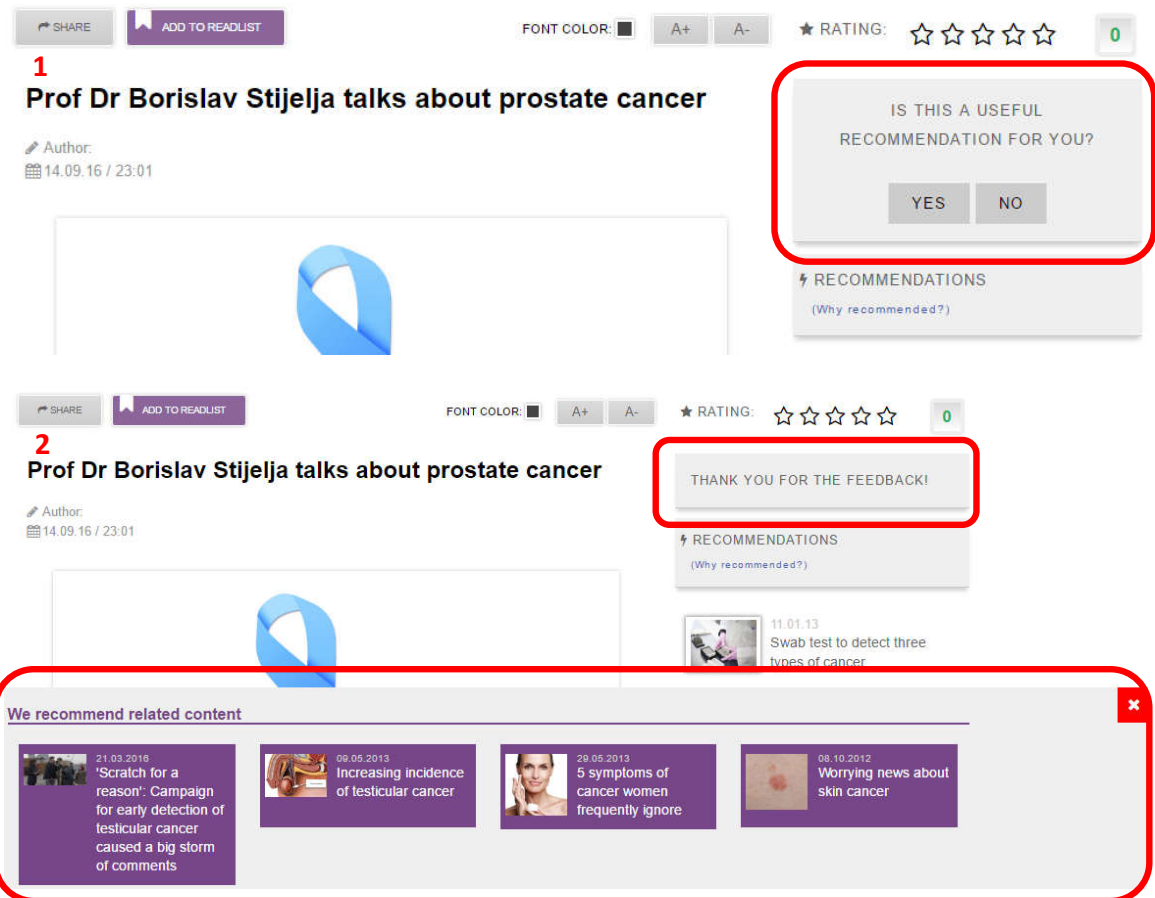
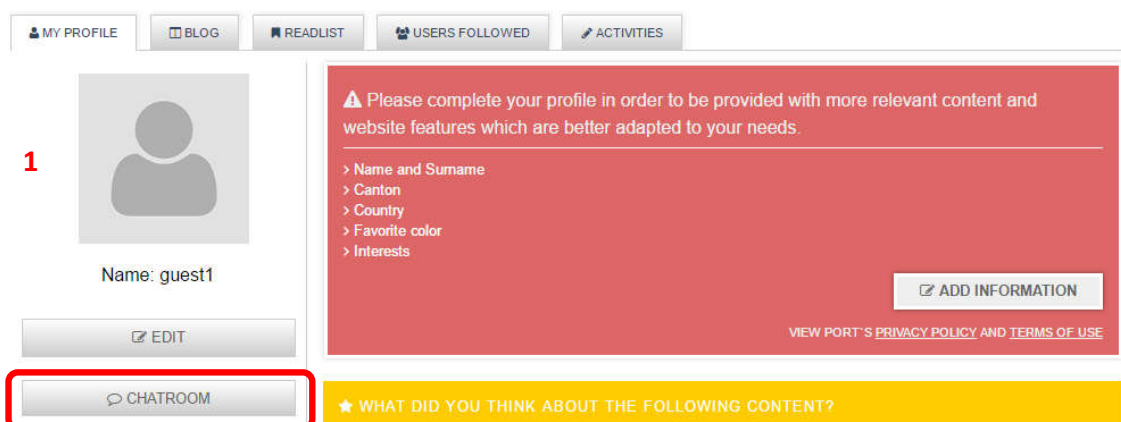


Figure A.29. Adaptive storyline (Recommending similar content to the one a user selected was useful; Clicking on any of the recommended content, and 1. answering with Yes to the question “Is this a useful recommendation for you?”, 2. opens a slider with recommendations of related, i.e., similar content.)



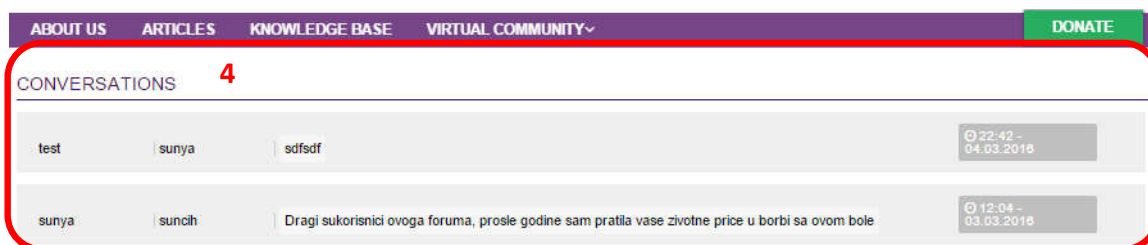
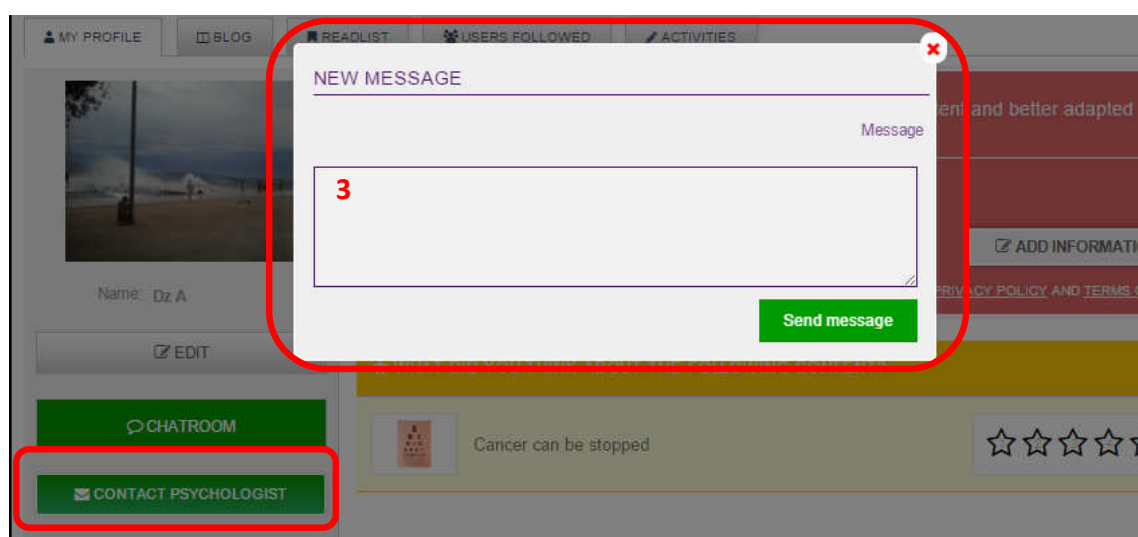
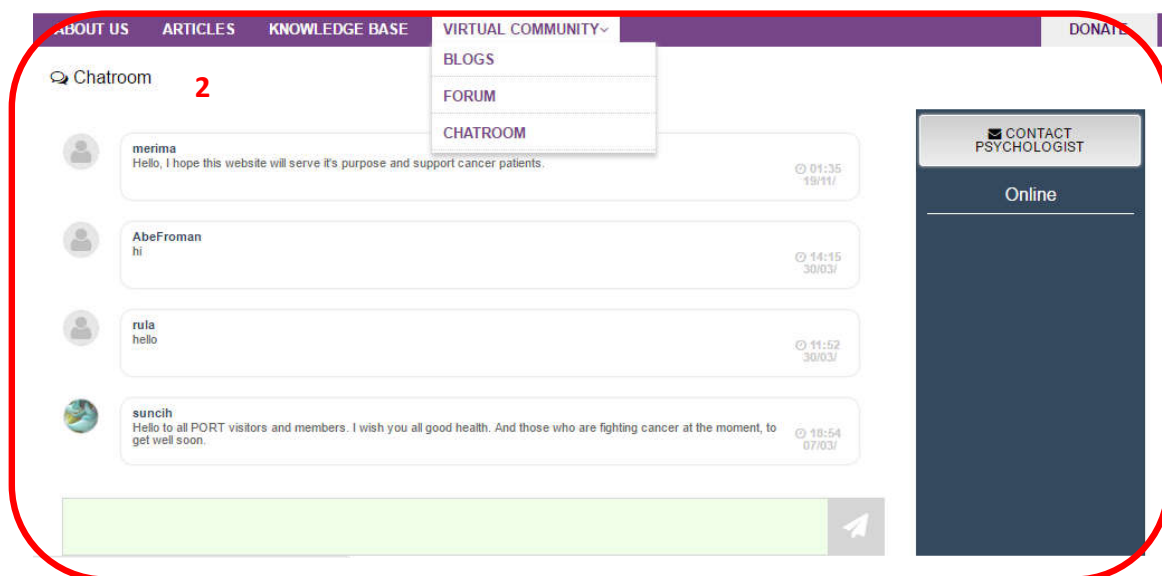


Figure A.20. Chatroom (1. Virtual community – Chatroom; 2. MyPORT – Profile – My Profile – Chatroom; 3. MyPORT – Profile – My Profile - Contact Psychologist; 4. MyPORT – Profile – Messages)

Appendix F

Emotion-based rules implemented on the Phase IV version of the PORT website

This appendix presents the emotion-based adaptation rules which were implemented on the latest version of the PORT website. The type of adaptation applied to the 25 features, which this research showed were affected by emotions, is explained in Appendix G. The features and content are labeled with F1 – F25. The two main types of adaptation that are used in this research are highlighting and hiding, as denoted with the *HighlightFeatures()* and *HideFeatures()* functions in the below rules. Moreover, the rules are categorised into those triggered by login emotions, during-use emotions and a combination of login and during-use emotions, as presented in the A3 algorithm in Chapter 5.

F.1 Rules for emotions reported at login

1. **IF** *surprise_login* = 0 **THEN** *HighlightFeatures*(F1 - User profile customisation, F5 – Selecting language, F10 – Information bubbles, F14 - Knowledge base recommendations, F15 - Article recommendations, F17 – Readlist)
2. **IF** *surprise_login* > 0 **THEN** *HideFeatures*(F1 - User profile customisation, F10 - Information bubbles, F14 - Knowledge base recommendations, F17 - Readlist) **AND** *HighlightFeatures*(F2 - Rating)
3. **IF** *surprise_login* = 4 *HighlightFeatures*(F11 - Blogs, F19 - Forum)
4. **IF** *anger_login* = 0 **THEN** *HighlightFeatures*(F1 - User profile customisation, F5 - Selecting language, F7 - Is this a useful recommendation for you?, F13 - Forum discussions recommendations)

5. **IF** *anger_login* > 0 **THEN** *HideFeatures*(F1 - User profile customisation, F7 - Is this a useful recommendation for you?, F13 - Forum discussions recommendations, F23 - Interests in profile editing) **AND** *HighlightFeatures*(F2 - Rating)
6. **IF** *disgust_login* = 0 **THEN** *HighlightFeatures*(F1 - User profile customisation, F3 - Commenting)
7. **IF** *disgust_login* > 0 **THEN** *HideFeatures*(F1 - User profile customisation, F3 - Commenting) **AND** *HighlightFeatures*(F14 - Knowledge base recommendations)
8. **IF** *sadness_login* = 0 **THEN** *HighlightFeatures*(F3 - Commenting, F9 - Filtering search outcomes)
9. **IF** *sadness_login* > 0 **THEN** *HideFeatures*(F3 - Commenting, F9 - Filtering search outcomes)
10. **IF** *shame_login* = 0 **THEN** *HighlightFeatures*(F8 - Filtering profile recommendation, F9 - Filtering search outcomes)
11. **IF** *shame_login* > 0 **THEN** *HideFeatures*(F8 - Filtering profile recommendation, F9 - Filtering search outcomes)
12. **IF** *fear_login* = 0 **THEN** *HighlightFeatures*(F8 - Filtering profile recommendation, F9 - Filtering search outcomes, F11 - Blogs, F19 - Forum)
13. **IF** *interest_login* = 0 **THEN** *HideFeatures*(F15 - Article recommendations)
14. **IF** *interest_login* > 0 **THEN** *HighlightFeatures*(F3 - Commenting, F5 - Selecting language, F6 - Greeting with user name, F15 - Article recommendations)
15. **IF** $1 \leq \textit{interest_login} \leq 3$ **THEN** *HighlightFeatures*(F4 - Adapting text colour)

16. IF *joy_login* > 0 THEN ***HighlightFeatures***(F19 - Forum)
17. IF *surprise_login* = 0 AND *shame_login* = 0 AND *joy_login* ≤ 3 THEN ***HighlightFeatures***(F21 - Profile recommendations)
18. IF *sadness_login* = 0 AND *fear_login* ≥ 2 THEN ***HighlightFeatures***(F19 - Forum)
19. IF *sadness_login* ≤ 1 AND *fear_login* > 0 THEN ***HighlightFeatures***(F25 - Profile)
20. IF *sadness_login* ≤ 1 AND *fear_login* ≥ 2 AND *anger_login* > 0 THEN ***HighlightFeatures***(F22 - Profile blog)
21. IF *sadness_login* ≥ 3 AND *anger_login* = 0 THEN ***HighlightFeatures***(F23 - Interests in profile editing)
22. IF *sadness_login* ≥ 2 AND *surprise_login* ≤ 2 THEN ***HighlightFeatures***(F18 - Articles)

F.2 Rules for emotions reported during use

23. IF *fear_duringuse* = 0 THEN ***HighlightFeatures***(F12 - Red rectangle in user profile)
24. IF *surprise_duringuse* ≥ 0 THEN ***HighlightFeatures***(F18 - Articles)
25. IF *surprise_duringuse* > 0 THEN ***HighlightFeatures***(F15 - Article recommendations)
26. IF *sadness_duringuse* = 4 THEN ***HighlightFeatures***(F16 - Categories)

27. IF *anger_duringuse* = 0 THEN ***HighlightFeatures***(F1 – User profile customisation)

28. IF *interest_duringuse* \leq 2 THEN ***HighlightFeatures***(F20 - Search)

F.3 Rules for combination of emotions reported at login and during use

29. IF *surprise_login* \leq 1 AND *joy_duringuse* $>$ 0 THEN ***HighlightFeatures***(F24 - Adaptive storyline)

30. IF *surprise_login* $>$ 0 AND *surprise_duringuse* \geq 2 THEN ***HighlightFeatures***(F13 - Forum discussions recommendations)

Appendix G

Types of adaptation applied to the PORT website

Based on the findings of this research (Chapter 7, Section 7.6), 25 different features and content types on the PORT website can be adapted to user emotions; the remaining features are not affected by adaptation. As explained in Chapter 5, two types of adaptation were implemented on the PORT website, which are highlighting and hiding.

G.1 Feature highlighting

Highlighting is applied as follows to these 25 features:

- *(F1) User profile customisation* – the notifications to go to the user profile and edit it are changed into brighter colours; the background for Edit profile link is coloured in green.
- *(F2) Rating* – the label ‘Rating’ next to the rating stars is coloured in green.
- *(F3) Commenting* – the text box for comments, and comments to content (commenting is enabled only for articles and blogs), is highlighted in green.
- *(F4) Adapting text colour* – the button and the label ‘Font colour’ are coloured in green.
- *(F5) Bilingual content* – the links for selecting content language (Bosnian or English) are coloured in green.
- *(F6) Greeting with user name* – the text of the welcome message is coloured in green.
- *(F7) Is this a useful recommendation for you?* – the text of the feature and the background of the response buttons (Yes/No) are coloured in green.
- *(F8) Filtering recommended content on the user’s profile* – the background of the filtering buttons (by Date, Content, Language, etc.) is highlighted in green.

- *(F9) Filtering search outcomes* – the filters for search outcomes is highlighted in green.
- *(F10) Information bubbles about data fields in profile editing* – are displayed with green background.
- *(F11) Blogs* – background of the link for Blogs, in the main website menu, is shown in green.
- *(F12) Red rectangle in user profile* – a green border is placed around the red rectangle, and the Add information button in the rectangle is colored in green.
- *(F13) Forum discussions recommendations (Forum main page)* – recommendations on top of Forum related pages are highlighted with a green border.
- *(F14) Knowledge base recommendations (KB page)* – recommendations on top of KB related pages are highlighted with a green border.
- *(F15) Article recommendations (on Articles pages)* - recommendations on top of Articles' related pages are highlighted with a green border.
- *(F16) Categories* - different categories of articles, KB articles and forum topics are highlighted with a green background.
- *(F17) Readlist* – the button 'Add to readlist' in all content types and the tab 'Readlist' in user profile page is highlighted in green.
- *(F18) Articles* – Articles link in the main menu is shown with a green background; Articles' titles are coloured in green wherever they occur on the website (Articles' main page, when opening a KB article, in Recommendations on user profile page).
- *(F19) Forum* – Forum link in the main menu is displayed with a green background.
- *(F20) Search* – the search boxes on the Home page, in the upper right hand corner of the website, in Forum and Blogs are shown with green backgrounds or green borders.

- (F21) *Profile recommendations* – content recommendations presented on the user profile page are highlighted with a transparent green background.
- (F22) *Profile blog* – the Blog tab within the user profile page is highlighted in green.
- (F23) *Interests in profile editing* – within the Edit profile page, the titles of different interest categories are coloured in green.
- (F24) *Adaptive storyline* – when recommended content is opened, the feature that asks for user feedback ‘Is this a useful recommendation for you?’ and response buttons (Yes/No) are highlighted in green; if Yes is selected, additional recommendations appear – the background of the Adaptive storyline is highlighted in green as well.
- (F25) *Profile* – the Profile link in My PORT drop down menu is highlighted with a green background.

G.2 Feature hiding

The website features are also adapted *to guide* the user *away* from them, if the emotions experienced by the user recommend that. **Hiding** is applied to fewer features:

- (F1) *User profile customisation* – all notifications that remind the user to go to the profile and edit it are turned off; the *orange triangle* in the upper right hand corner of the website and the *red rectangle* on the user profile page are *removed*. The user could still edit the profile, by reaching it via menus, but it would have to be a purposeful action on their behalf.
- (F3) *Commenting* – the text box for comments is *hidden*, instead only a link with the label ‘Comment’ is left; if clicked, the text box is opened.
- (F7) *Is this a useful recommendation for you?* – the question for giving feedback is removed from all content recommendations.

- (F8) *Filtering recommended content on the user's profile* – only a link to the filter (the word *Filter*) is presented; if clicked, the full filter is opened, visible as in the version without hiding.
- (F9) *Filtering search outcomes* – the filter (apart from the tabs representing filters by content type) is replaced with a link *Filter*; if clicked, the full filter opens.
- (F10) *Information bubbles in profile editing* – the bubbles colour is changed from yellow to grey to resemble the background colour of the Edit profile page, and hence be less visible.
- (F13) *Forum discussions recommendations (Forum main page)* – the background of the recommendations on top of Forum related pages is blended with the grey website background, instead of the default purple colour.
- (F14) *Knowledge base recommendations (KB pages)* – the background of the recommendations on top of KB related pages is changed from purple to grey, to be less visible.
- (F15) *Article recommendations (on Articles pages)* – the background of the recommendations on top of Articles related pages is coloured in grey.
- (F17) *Readlist* – the background of the button 'Add to readlist' is changed to grey colour, to be less visible.
- (F23) *Interests in profile editing* – within the Edit profile page, the *interest categories* can only be expanded when clicked on, unlike the default case when they automatically open upon hovering over them; also, *notifications for completing interests* in the *red rectangle* on the user profile page are turned off.

Appendix H

Summary of hypotheses results

	Hypothesis	Study 1	Study 2	Study 3	Study 4	Study 5
Target users	H 1.1 1 Target users are mainly indirectly affected by cancer and they go online to seek for cancer information for someone else.	All from B&H; mean age 35.7; majority: Indirectly affected (family member); female; breast or lung cancer; use Internet for health information	Avg.age 25.8; females (50.6%); all from B&H; family member(s) had cancer (33.3%), interested in cancer information (33.3%)	Avg. age 27; females (61.2%); 12 countries - B&H (51%), US (33.7%); family member suffered from cancer (54.1%), interested in informing themselves about cancer (30.6%)	Avg. age 25.8; females (65.6%); 8 countries, most frequent - Jordan, B&H, US; family member suffered from cancer (37.7%), interested in cancer information (35.2%)	Avg. age 30.3; females (54.5%); 11 countries, most frequent - US, UK, Germany, Italy, B&H; family member suffered from cancer (54.5%), interested in cancer information (40.9%)
	H 1.2 2. The majority of health websites in B&H and the UK have adopted no personalisation or only basic personalisation services.	Advanced features lack on B&H and UK websites.				
Adoption of personalisation	H 1.2 3. The majority of people affected by cancer would like to have personalisation features on cancer websites.	Majority use non-personalised websites; would like personalisation ; marginally preferred adaptability				
Preference for (emotion-based) personalisation	H 1.3 4. A personalised cancer website is perceived more usable than a non-personalised one.		Supported (personalised website was usable (more than original/non-personalised website))	Not supported (but: CG1 mean usability > CG2 mean usability)		
	H 1.4 5. Users find the cancer website with emotion-based personalisation more usable than the one with generic personalisation, and the latter more usable than the non-personalised				Not supported (but: EXT mean/median usability > 68 threshold; EXT median usability > PRE > DEF)	Not supported (but: E median usability > P)

Usefulness of personalisation features	website.					
	H 1.4 6. Users of cancer websites prefer emotion-based personalisation to generic personalisation services.					Not supported (but : 47.1% preferred E version, 40.1% preferred P)
	H 1.4 7. In the same aggregated affective state, users find a website with emotion-based personalisation the most usable, followed by the website with generic personalisation, and lastly the one without personalisation.				Partially supported (PAAS -> EXT most usable; neutral state -> DEF most usable; NAAS -> PRE most usable)	
	H 2.1.1 1. People affected by cancer perceive personalisation features they are offered on a cancer website as useful.		Supported	Supported	Supported	Supported
	H 2.1.1 2. Personalisation features recommended to users based on their emotions are the features users rated the highest in terms of usefulness.				Partially supported	Partially supported
	H 2.1.2 3. User background characteristics influence the perception about the usefulness of personalisation features.		Not supported	Partially supported (age (+))	Partially supported (for gender and cancer-effect)	Not supported
	H 2.1.3 4. Positive emotions stimulate the use of health websites for cancer information search, while negative emotions have a negative effect.	Partially supported (fear, interest (sadness and surprise potentially))				

H 2.1.4 5a. Overall intensity of pre-use positive emotions positively affects the perceived usefulness of personalisation features.		Not supported	Not supported	Supported	Not supported
H 2.1.4 5b. Overall intensity of pre-use negative emotions negatively affects the perceived usefulness of personalisation features.		Not supported	Supported	Not supported	Not supported
H 2.1.4 6a. Discrete pre-use positive emotions positively influence how useful each individual personalisation feature is perceived.		Partially supported (at 0.05 sig. level: <i>interest</i> and 5 features; <i>excitement</i> and 1 feature)	Partially supported (at 0.05 sig. level: <i>joy</i> and 1 feature; <i>interest</i> and 2 features; <i>excitement</i> and 1 feature; <i>calmness</i> and 3 features; <i>awe</i> and 4 features)	Partially supported (at 0.05 sig. level: <i>joy</i> and 6 features; <i>interest</i> and 8 features)	Partially supported (at 0.05 sig. level: <i>joy</i> and 1 feature; <i>interest</i> and 9 features)
H 2.1.4 6b. Discrete pre-use negative emotions negatively influence how useful each individual personalisation feature is perceived.		Partially supported (at 0.05 sig. level: surprise, disgust, anger, fear, shame, sadness, contempt)	Partially supported (at corrected α : <i>embarrassment</i> and 1 feature (-); <i>boredom</i> and 1 feature (-); <i>fear</i> and 2 features (-); <i>sadness</i> and 1 feature (-); <i>surprise</i> and 2 features (-); at 0.05 sig. level: surprise, guilt, boredom, sadness, fear, anxiety, embarrassment)	Partially supported (at corrected α : <i>anger</i> and 1 feature (+) and 2 features (-); <i>surprise</i> and 2 features (+) and 1 feature (-); at 0.05 sig. level: disgust, anger, sadness, surprise, guilt)	Partially supported (at corrected α : <i>disgust</i> and 1 feature (-); at 0.05 sig. level: disgust, anger, fear, shame)

	H 2.1.4 7. Emotions users feel at the start and during website use can predict which content and features they will interact with.				Partially supported (surprise (login and during) and 6 features; shame and 1 feature; joy (login and during) and 2 features; fear (login and during) and 3 features; sadness (login and during) and 4 features; anger (login and during) and 3 features; disgust and 1 feature; interest (during) and 2 features)	Partially supported (interest (login and during) and 6 features; joy and 2 features; surprise (login and during) and 2 features; sadness (during) and 1 feature; shame (login) and 1 feature; disgust (during) and 2 features)
	H 2.2 8. Users of personalised cancer websites prefer adaptability over adaptivity.			Supported		
	H 2.2 9. Users of personalised cancer websites find adaptability more useful than adaptivity.				Supported	Not supported
	H 2.2 10. Depending on their background, users differ in their preference for a personalisation approach.			Not supported	Partially supported (for gender and cancer-effect)	Not supported
	H 2.2 11a. Users experiencing negative emotions of high intensity perceive adaptivity useful (they prefer adaptivity).			Supported (negative emotions -> preference for adaptivity)	Not supported	Not supported
	H 2.2 11b. Users experiencing positive emotions of high intensity perceive adaptability useful (they prefer adaptability).			Not supported	Supported	Supported
Satisfaction	H 2.3 12. Majority of users express satisfaction with cancer website			Supported	Supported	

Usability	personalisation.					
	H 2.3 13. If users perceive cancer website personalisation features as useful, they will also be satisfied with the website's personalisation.			Supported	Supported	
	H 2.4 14. Background characteristics influence how usable users perceived a personalised cancer website.		Not supported	Partially supported (age (+))	Partially supported (country: B&H participants gave higher usability scores)	Not supported
	H 2.4 15. The more useful cancer website personalisation features are perceived, the higher the website usability.		Not supported	Supported	Supported	
	H 2.5 16a. Negative emotions post-use have lower intensity than negative emotions pre-use.		Not supported (fear and sadness increased)	Not supported	Partially supported (sadness <i>decreased</i> ; fear, surprise and anger <i>increased</i>)	
Emotions post-use	H 2.5 16b. Positive emotions post-use have higher intensity than positive emotions pre-use.		Not supported (happiness and excitement decreased)	Partially supported (surprise <i>increased</i> , happiness (and calmness) <i>decreased</i>)	Not supported (interest and joy <i>decreased</i>)	
	H 2.5 17a. The greater the satisfaction with website personalisation, the less intensely are negative emotions experienced after website use.			Not supported (but boredom (-))	Not supported	
	H 2.5 17b. The greater the satisfaction with website personalisation, the more intensely are positive emotions			Supported (and for interest and excitement)	Not supported	

	experienced after website use.					
	H 2.5 18a. Users who do not perceive the website as usable will experience high intensity of negative emotions post website use.		Not supported	Supported (for: negative emotions mean intensity; and boredom (-), fear (-))	Partially supported (for: shame (-), disgust (-); <i>potentially at 0.05 level: anger (-), sadness (+)</i>)	
	H 2.5 18b. Users who perceive the website as usable will experience positive emotions in high intensity post website use.		Not supported	Supported (positive emotions mean intensity; and interest; <i>potentially at 0.05 level: joy</i>)	Not supported (<i>potentially at 0.05 level: interest (+)</i>)	
	H 2.5 19a. Perceived usefulness of adaptability or adaptivity increases the intensity of post-use positive emotions.				Supported (positive emotions mean intensity; and interest)	
	H 2.5 19b. Perceived usefulness of adaptivity or adaptability decreases the intensity of post-use negative emotions.				Not supported (at 0.05 level: surprise (+))	
Reuse intentions	H 2.6 20. People affected by cancer intend to reuse a personalised cancer website.		Supported	Supported	Supported	
	H 2.6 21. Satisfaction with cancer website personalisation and intentions to reuse the website are positively associated.			Supported	Supported	
	H 2.6 22. Usability of a personalised cancer website and intentions to reuse the website are positively associated.		Supported	Supported	Supported	

	H 2.6 23a. The higher the intensity of post-use positive emotions, the higher the website reuse intentions.		Supported (for post-use positive emotions mean intensity; and for: interest (+); but excitement (-))	Supported (for post-use positive emotions mean intensity; and for: interest (+), <i>surprise</i> (+), excitement (+); potentially awe (+))	Partially supported (interest (+))	
	H 2.6 23b. The lower the intensity of post-use negative emotions, the higher the website reuse intentions.		Not supported (guilt (+))	Partially supported (boredom (-); fear (+); <i>potentially sadness</i> (+))	Not supported (post-use negative emotions mean intensity (+); sadness (+); fear (+))	

Appendix I

Study 4 Interviews

The *second round of interviews with target users* aimed at gaining a better understanding of target user preferences for emotion-based personalisation on a cancer website. *One man and three women affected by cancer*, from B&H, were interviewed in Spring 2016.

I.1 Methodology

The interviewees were named here as follows: IntTHS, IntSNK, IntVMS and IntSUS. The interviewees were in early twenties (interviewees IntSNK and IntTHS), late thirties (interviewee IntVMS) and early sixties (interviewee IntSUS). They were affected by cancer in the following mannered:

- IntSUS interviewee is a cancer association's president and former breast cancer patient;
- IntVMS is a daughter of a deceased ovarian cancer patient;
- IntSNK is a young undergraduate law student, former cancer patient who suffered from Non-Hodgkin lymphoma;
- and IntTHS is a young undergraduate law student and former cancer patient; he suffered from Osteosarcoma.

On average, the interviews lasted between 1 and 1.5 hours. They were organised in public places, and one was conducted via Skype. The interviewees were first asked background information about themselves, how they were affected by cancer and which cancer types. Next followed the main part of the interviews – which was *observing how target users interact with the three versions of PORT's website*.

I (the interviewer) provided my laptop, explained the experiment procedure, instructed the interviewees which website version to visit and observed the interaction with the system. As the time assigned for the interview was not sufficient for a first time user to navigate around the website themselves and notice its distinguishing features, the interviewer navigated the websites as per user instructions, to streamline the interview.

This approach was particularly applied for the Skype interview – screen sharing – and the case of the IntSUS interviewee who was insecure in using new technology and expressed preference that the interviewer navigated the website.

Three versions of the PORT website were visited for this interview:

- DEF – without personalisation
- PRE – generic personalisation
- EXT – emotion-based personalisation.

These were explained in Chapter 4. The website versions were visited consecutively and were shown in a different order to each interviewee. The same activities were performed on all the website versions. The interviewer interacted with the websites, stating which website version she was using at that moment and what actions she was carrying out. Interviewees were asked to select the features and content to interact with on a specific part of the website, as well as to report their emotions via the website's Emotion Tool.

After presenting all three website versions, the interviewer showed them on the screen one next to the other. The interviewees were then asked to identify the following:

- *the website version they preferred* and would rather choose to use
- *negative and positive impressions* about each website version
- point out the *features* they noticed and how useful they found them.

1.2 Interviewees' preferred website versions

Manual *qualitative analysis* was applied to the interview data. This section reports on user preference for one of the three levels of personalisation on a cancer website.

Interview results implied that a cancer website with *personalisation* was users' *preferred choice*, whereby:

- *EXT: website with emotion-based personalisation* – preferred by IntTHS and IntSNK.

- *PRE: website with generic personalisation* – preferred by IntSUS, but in comparison only to the default version (she used only two website versions). In essence, she expressed a preference for having personalisation.
- *DEF: Website without personalisation* – IntVMS preferred this version.

Interviewees made the following comments for the website version with **emotion-based personalisation**:

IntSNK: *I would choose, because really the differences are minimal, I would be indifferent... **If the content is the same, functionality-wise, I think all three are OK...** Well, lets say, **this first one [EXT]**, where I am logged in... **I would choose that one, as someone who uses this all the time.***

The website version IntSNK would recommend to a friend: *As I said on **the first [EXT]**, because it offers many more options.*

IntTHS: *I like **the third [EXT]** the most because it **has a lot of options**, a lot more options than the first two... With regard to the profile, I certainly like that you can choose, that it offers you what you are interested in...these emotions I also like that they are not boring to pop-out all the time but only when I rate something... Well, **I would use this third one [EXT]** ...except for these small things to be changed...*

The reasons IntSUS interviewee preferred **generic personalisation** were the following.

IntSUS: *Even without seeing I know which I would choose....I am open... I am pro communication without gloves. **Without any ambiguity, I am for the first version [PRE].***

The website version **without personalisation** was preferred by the IntVMS interviewee.

*The first [DEF], I would choose. It is **more acceptable**...It is **clearer** [better organised] ...It has a **nice background, it is simple**... There are **no duplications on the forum**...*

However, for each of the website versions IntVMS made similar positive comments. For DEF she claimed: “*The colours are **not intrusive**. It is **divided nicely**. It is **easy to use**.*” For PRE she said: “*The whole website is positive. Nicely arranged. It is not difficult to figure out how to use it. It is dynamic, but yet adapted [tailored].*” Finally, for EXT, IntVMS stated: “*It has more content, it is better...but if you register...*”

Perhaps one of the reasons for choosing the first version she interacted with (DEF), was the initial impact of being shown a website she needed, but did not have, at the time her mother was ill. IntVMS was saying throughout the interview: “*This is excellent, super, bravo, great. All I needed when I went through my experience, but did not have.*” Consequently, when she started exploring the PORT website (she first interacted with the default version), she said: “*It is as if you had somehow heard my needs from before and have it all here.*”

I.3 Positive and negative impressions about the website versions

This section categorised interviewee comments about each website version (Table A.3 – Table A.5) into those that reflect their positive and negative impressions.

Table A.3. Impressions about the website with **emotion-based personalisation** (EXT)

Positive	Negative
IntVMS: It has more content, it is better...	IntVMS: Forum categories are worse... Grey colour is prettier... So design
IntVMS: There are emotions... comments... recommended...	IntVMS: The purple stands out too much... Too many colours thrown in...
IntVMS: [emotional response evoked] Positive... Forum... it unifies a lot of information. The sense of community...	IntVMS: I wouldn't duplicate on the forum both categories and recommendations . [these features are available on all website versions]
After IntTHS logged in, the emotion tool popped out , he exclaimed with a positive tone “ Wow there is a lot here. ”	IntTHS: I have a question, these parts here [the dark purple background on the main link banner for some links as a result of adaptation], e.g. this white and so on , was
IntTHS: I like the third [EXT] the most	

<p>because it has a lot of options.</p> <p>IntTHS:... with regard to the profile, I certainly like that you can choose, that it offers you what you are interested in...these emotions I also like that they are not boring to pop-out all the time, but only when I rate something.</p> <p>IntTHS: But I like this better [EXT]... because it draws attention [<i>referring to the purple background on the recommendations within content types</i>]</p> <p>IntTHS: It [highlighting] offers a lot more...instead of me going and searching on my own. For example this, according to my choice, all I have written about myself and probably on the profile, what I have chosen, it offered me some of the things that might be useful...and there I did not read this 'We recommend' I wouldn't even get what this is</p> <p><i>Interviewer:</i> So there it was not pointed out enough and like this you like that it is pointed out. Also on the profile, there is also a form of recommendation...</p> <p>IntTHS: Yes. And chatroom and the Contact psychologist.</p> <p>IntTHS: I like this part because it has a lot more options, and this as well, and profile, and messages and all that, and because it is distinct, it is easily found.</p> <p>IntSNK: I think the left [EXT version] is prettier, because it has more purple, even though, to be honest, I did not notice those articles on this first version as much as I did on the other, even though I see they are given on both. I don't know why because it would make</p>	<p>this so before or?</p> <p>IntTHS: I like the third [EXT] the most .. except for those little details in appearance [<i>squares in the main link banner falling out of line</i>]...</p> <p>IntTHS: I don't know, for example for all this to be the same...because this, seems like I have already chosen it [<i>the dark purple background on the main link banner for some links as a result of adaptation</i>]...it confuses a little.</p> <p><i>Interviewer:</i> And would it direct you to click on it, or would it irritate you thinking that you already clicked it?</p> <p>IntTHS: Eh, the second thing... only because of appearance... maybe if it were not a square, but if it were a little yellow, just a thought, just to let me know... because it is confusing a bit this way, as if it is an error on the website.</p> <p><i>Interviewer:</i> You said you would like to use this version. Was there anything negative, apart from the way the content is highlighted that it is confusing...Was there anything else negative that would bother you or did bother you to use it.</p> <p>IntTHS: For me personally no. Maybe if I were to really use it I would notice some things, but this way no. ... And then this, even though I saw all have Categories, <i>the most read</i> as well, and this too, just if it were coloured this way but that you excluded emotions. But for example that emotions were below, in grey, like in a second plan. So that in the focal point is that what interests me, what I came to the website for, to inform myself about tumours or [<i>referring to the profile recommendations, their arrangement, colour and based on what they are generated</i>]...</p>
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<p>more sense that the purple ones are noticed faster.</p> <p>Interviewee SNK would recommend to a friend "... the first, because it offers many more options, including the "Ask the psychologist"."</p> <p>IntSNK: ...recommendations are always a good thing to have, because, you can't think of everything to search for that you need, and something that pops up, maybe you didn't think of it</p>	<p>IntTHS: Well I do not know...What emotions are, how will they direct me... In the case of someone who has just learned he is ill, and therefore experiences negative emotions, will the website lead him only to the part of the website shown to people who feel negatively? However, such a person might be interested in finding out all about his illness, and maybe the website that filters information based on emotions will prevent him from reaching all the desired knowledge.</p> <p>...well in the first plan for the system to recommend me based on that cancer, and beneath to recommend me also based on the emotions. But in the first place to be that what I am interested in.</p>
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Table A.4. Impressions about the website version with **generic personalisation (PRE)**

Positive	Negative
<p>IntVMS: The whole website is positive. Nicely arranged. It is not difficult to figure out how to use it. It is dynamic, but yet adapted.</p> <p>IntVMS: [emotional response evoked] Fulfilment. The whole website is positive.</p> <p>IntTHS: And then we have the first one [PRE]...the first has that personalisation, it has My profile, which is nice...and is this logged in?...well I do not know. It also sort of looks nice...And here as well that I can choose emotions...</p> <p>Within Knowledge base, the interviewee IntTHS noticed recommendations and said all are useful.</p> <p>IntSNK: With regard to the third version [PRE], honestly, I don't know why, it is somehow prettier... seems as if the user interface is arranged in a nicer way. On top... that – maybe you will like these articles, or, on the side it has categories... from what I saw on the previous version that was not so arranged.</p>	<p>IntVMS: The button Donate – two is too much...I think author and time should go below the article text...I wouldn't duplicate on the forum both categories and recommendations.</p> <p>IntTHS: I like it better when I rate something that it asks me which emotions I feel, because half of the people will never open this [emotion tool]...if it doesn't open on its own, they won't open.</p> <p>IntSNK: The only thing I lack on it is that "Ask the psychologist", because I think that is a great option, in Chatroom.</p>

<p>It somehow appears more finalised.</p> <p>IntSNK: ...in any case that it is more to the design, I would say...the difference is in colours [on the profile]...</p> <p><i>Interviewer: Appearance-wise, it suited you more?</i></p> <p>IntSNK: Yes.</p> <p>IntSUS: [Website interaction evoked] Calm and pleasant... Satisfaction... Happiness that a person can obtain information and can for themselves sort out certain things...</p> <p>I have noticed a difference just now, that you have greater possibilities if you identify yourself... I would always recommend that first one [PRE compared to DEF]... [T]he first one is more complex, but because of that you also get more.</p>	<p>IntSUS: And the first [PRE] one is more complex...</p>
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Table A.5. Impressions about the website version without personalisation (DEF)

Positive	Negative
<p>IntVMS: Positive [emotional response evoked]. I am glad.</p> <p>IntVMS: The colours are not intrusive. It is divided nicely. It is easy to use... It is more acceptable...It is clearer...It has a nice background, it is simple... There are no duplications on the forum...</p> <p>IntSNK: I think, if I needed to find something in a jiffy, to find out some article, maybe I would not register... As I said, for someone who needs it for one-time-use then it is alright...</p> <p>IntSUS: The second [DEF] one is simpler.</p>	<p>IntVMS: You have to register to rate.</p> <p>IntSNK: The second [DEF] is less usable, but because you are not registered. But, umm, it depends on why you came to the website...I notice that here those recommendations are not there... but that is because they are not registered. As I said, for someone who needs it for one-time-use then it is alright, but not for someone who would need use it multiple times, I think they should register, if they want to simply participate in that community.</p> <p>IntTHS: Well it [DEF] lacks that aspect of personalisation...</p> <p>Interviewee IntTHS noticed that adapting colour and font was missing. Noticed the virtual community did not have a Chatroom.</p>

Appendix J

Study 5: Interviews with cancer sufferers who are long-term users of the PORT website

J.1 Interviewee IntTHS

The interview with IntTHS was carried out on 20 March 2017 in Sarajevo, B&H. The interviewee IntTHS is a former cancer patient who battled osteosarcoma. IntTHS is male, undergraduate student, in early twenties, and is from B&H.

He was first introduced to the PORT website during the interviews carried out in spring 2016. He then used and evaluated Phase II and Phase III website versions. He has since then used the latest version of PORT website several times and has experience with it.

J.2 Interviewee IntLA

The interview with IntLA took place on 22 March 2017 in Sarajevo, B&H. The interviewee, referred to as IntLA, is a female, employed, has a Master's degree, age group – early thirties, lives in Sarajevo and is from B&H. She is a cancer patient, currently being treated for non-Hodgkin's lymphoma cancer. She was diagnosed with cancer in fall 2016.

She was first introduced to the PORT website in 2015, as she participated in Study 2 evaluations of the Phase I website version. She has since then used the latest version of PORT website several times and has experience with it.

J.3 Interview procedure

1. Interaction with the latest PORT website version

The interviewees were first instructed to freely use the website for a few minutes. The interviewer observed *which emotions were reported* and which features and content they then used on the website. The research argument is that emotions users feel at the start and during website use can predict which content and features they will interact with.

2. Demonstrating three website versions: without personalisation, with generic personalisation and with emotion-based personalisation

I next presented three versions of the PORT website, consecutively. I highlighted that all website versions were the same in terms of appearance and the amount of content available.

A. First shown was the version *without personalisation*

I opened all the main links to all content types. First opened and demonstrated was the content available on the Articles pages. Next, the Knowledge base content. Then, I briefly showed the forum content on the main page and within a forum discussion. Finally, I opened the blogs main page, scrolled through the available posts and opened one blog post.

B. Second shown was the website with *generic personalisation*

I explained that a user has to register and log in to the website to receive personalisation. I logged in with one of my guest accounts for a new user. I explained that to receive better personalisation users should provide some information about themselves by completing their profile data. I visited the Edit profile page, and completed some of the background data, and specified for each interest category, one interest.

I then viewed an article and rated it highly, as well as a forum discussion, but rated it with a low rating.

I then logged back into the website for the changes to profile data to affect content recommendations. I showed again all content types as I showed on the first website

version. I pointed out that all the content was presented in the same way as on the first website version, however also pointed to the top of the page of all content types, where the recommendations were presented.

I then showed that this version also has a private part of the website, which enables the user to view their Profile page. Upon opening the profile page, I explained the content recommendations are presented and generated based on the interests the user specified, and the content preferred (highly rated). I showed that the interests I previously specified were matched and, as only articles were recommended, the preferred content was also matched.

I pointed out that in addition to the recommendations, this website version has several other features which the first version did not, for example: Notifications bell with an orange triangle, and similar notifications on the profile page (red rectangle).

C. The website version with *emotion-based personalisation* was last presented.

The same steps were taken as on the second website version. However, while rating content on this website version, emotions were reported.

I reported positive emotions for an article I gave a high rating to. I also gave a high rating to a forum discussion, but reported negative emotions. I rated a few other pieces of content, with a lower rating.

I showed all the content on the different segments of the website, as on the first two versions of the website. I pointed out all the content was available, as on the first and second website version. Moreover, as the second website version, this too offers within all types of content, additional recommendations.

I logged back into the website. The first time with *positive emotions*. I then visited the Profile page, where I demonstrated by clicking on the feature ‘Why recommended?’ the profile recommendations were generated based on the positive emotions, and it was only articles that were recommended, those that reflected user interests, that are similar to the

one that was given a high rating, while other content type was not recommended because during the previous session, I gave a high rating to an article and for that rating specified to have felt positive emotions.

I logged into the website again, now with *negative emotions*. I followed the same steps to show that the profile recommendations indeed show only forum discussions, reflecting the one I gave a high rating to, while also reporting negative emotions with it.

I then pointed out the features which were distinguishing for this website version, including the content recommendations tailored to emotions, the Emotion Tool, and feature highlighting and hiding.

I used the Emotion Tool several times to report different emotions, and thereby demonstrate that the changes in emotions affect different parts of the website or its features to be highlighted in green, or others to be hidden.

J.4 Interview questions

1. The first part of the interview asked the interviewee to identify the website version she/he would prefer and rather use:
 - i. A. without personalisation, B. generic personalisation, C. or emotion-based personalisation?
 - ii. And why?
2. The results of my previous studies have indicated the following. Users more frequently claimed to *prefer the website that offers emotion-based personalisation*. Why do you think users interested in cancer-related information would prefer emotion-based personalisation to other personalisation on a cancer website?
3. The previous studies' findings show that users like the website that offers emotion-based personalisation because of the appearance, design or colours on the website.
 - i. If this is the website version you prefer, do you also like it because of this?

- ii. Did you notice and what changes in the website appearance?

4. My previous studies' results have also shown that a larger number of users have chosen the third website version – with **emotion-based personalisation**. However, the number of users was not significantly larger. In other words, if users were shown all three website versions – without personalisation, generic personalisation and emotion-based personalisation, there would not be a significant difference in user choices. They would not significantly prefer any one of the three website versions, it would be more or less the same to them which they were using.
 - i. In your opinion, why do you think the difference is so small? Why do you think that users do not significantly prefer personalisation to no personalisation offered, and moreover emotion-based personalisation over generic personalisation?

5. Results showed that users found the following features the most useful on this website. These were the top ranked in terms of usefulness [I demonstrated each feature on the PORT website]:
 - **articles recommendations**
 - **content recommendations** of profile page
 - **knowledge base recommendations**
 - **“Is this a useful recommendation for you?”**
 - **adaptive storyline** (adaptive navigation – direct guidance)
 - **Emotion Tool appearance**
 - **defining personal interests**
 - i. Why do you think these were the features users found the most useful?
 - ii. Do you also like them the most, find them the most useful? If not, which do you like better?

6. The next part of the interview inquired about why previous users **rarely clicked on the recommendations on their profile page**. On the one hand, users claimed they

- find the feature useful, they want that kind of a feature, however, on the other, it does not appear they use the feature, they do not interact with it on the website.
- i. Why do you think that is?
 - ii. When you go to your profile page, is there something that you first notice, that draws your attention? Perhaps users are not aware they are offered content recommendations on this page?
 - iii. Do you notice the recommendations? Would you click on them?
7. The results further showed users were mainly neutral about the usefulness of the following features, or did not consider them as useful [I demonstrated each feature on the PORT website].
- **tailoring website background**
 - **adapting text colour**
 - **greeting with username**
 - reporting emotions at rating and on cancer website overall
 - “What did you think about the following content?”
 - red rectangle notifications
- i. Why do you think that is?
 - ii. In your opinion, should these be the bottom ranked features?
 - iii. If not, which do you consider the least useful for this website?

8. The following part of the interview addresses the questions about the **Emotion Tool** and **reporting emotions** on the cancer website.

The results also show inconsistencies about the Emotion Tool. Users in my previous studies claimed they liked the Emotion Tool – appearance-wise and the options it offers. However they were neutral about reporting emotions at rating and on cancer website overall. Some have even stated that they are irritated by the ‘constant appearance’ of the Emotion Tool, that they do not see the purpose of reporting

emotions; overall they did not consider reporting emotions at login or at rating as something they find useful.

- i. If we are to assume a user came to the website knowing it offers emotion-based personalisation, why do you think they were indifferent/neutral about this feature, type of service.
 - ii. Why do you think users have mixed feelings about the **Emotion Tool** and reporting emotions on a cancer website?
 - iii. How do you feel about the Emotion Tool:
 - a. its appearance;
 - b. it being available on the website;
 - c. it popping-up at login and rating;
 - d. overall, being asked to report your emotions?
9. The interviewees were pointed out that in addition to content recommendations, emotions trigger adaptation of website features.
- i. Do you believe users notice these changes to the website?
 - ii. While using the website, did you notice that certain parts were highlighted?
 - iii. While using the website, did you notice that certain features were not shown?
 - iv. What do you think about these changes? Do you think that is useful? Or is it something that irritates, that bothers you?
10. The findings of this research have also shown that the personalisation features recommended to the user based on their emotions are among the features users rated the highest in terms of usefulness.
- What do you think about these features, about their usefulness, and their usefulness in comparison to the other website features?

Appendix K

Study of longitudinal use of the PORT website

The longitudinal study carried out in Spring 2016 is reported in this section.

Methodology: This study focused on user interactions with the PORT website with emotion-based personalisation (Phase III version). The aim was to explore how users interact with the website – the features and content they visit and use - in different affective states, and over a longer period of usage.

There were nine participants in the study - 3 male and 6 female; all native Bosnian speakers, Bosnians; living in B&H, Germany, UK and Netherlands. They used the PORT website for a period of one month in Spring 2016. During this time, the number of times a single user interacted with the website ranged from 2 to 7, spending anywhere between 5 to 30 minutes per visit.

Dataset: The website logged the following data – emotions users reported at login and during use, and when a website feature or content was clicked on. The resulting dataset consists of 29 cases (i.e., instances of website use), 50 features and content types, 9 login emotions, and during-use emotions. During a single website visit, a user could have interacted with a feature or content type *zero times*, *once* or *more*. The exact number of interactions was recorded. Moreover, not all users reported emotions at login every time they used the website, and not all reported emotions during use, or reported emotions during use but fewer than four times. Furthermore, at each use of the Emotion Tool, users did not necessarily report the intensity of all nine emotions studied here.

Analysis and results: The following was analysed in longitudinal use of the PORT website:

1. Which features and content are repeat website visitors more likely or less likely to interact with?

2. Do emotions influence the type of features and content repeat visitors interact with?

1. Features and content

According to the logged data, participants did not visit or click at all the following features and content: blog tab on the Profile page, tailoring website background on the Edit profile page, orange triangle with user notifications, greeting with the username, chatroom, messaging a psychologist, support us, privacy policy and terms of use.

Table A.6 lists the features and content participants interacted with, showing the mean frequency of interactions, standard deviation, and sum - the total number of times a feature/content was visited by all users. The table distinguishes between individual website features, i.e., functionalities, which are shown with a white background, and website content or general pages, shown in with a grey background. It should be noted that user profile customisation was observed in three cases – visiting the Edit profile link, counting the number of basic/demographic data fields completed out of the total 9 fields, and counting how many of the interest categories (of the total four) a user edited.

The findings show that the features with the highest *average number of interactions* were: *adding content to the readlist*, *visiting the profile page to edit* basic/demographic information and interests. Nevertheless, the features and content that were *visited the most*, based on the total number of uses, were: *articles-related content*, selection of *categories* of various content types, *rating* content, *knowledge base* related content, *edit profile* page, and *giving feedback* about the usefulness of a recommendation.

The features and content that have been *used the least* included: *tailoring background color*, *recommendations for blogs*, *filtering search outcomes*, *viewing* the personal *readlist*, *sharing* a content, *sending a private message* to another user, *posting a reply* to a *forum* discussion, *using* the search, *viewing* another user's profile, *clicking* on the *Contact* link. These features are not presented in Table A.6. Each of these features has been clicked on in total one time.

Table A.6. Frequency of interactions with website features and content

	Mean frequency	SD	Sum
Add to readlist	10.0		10
Edit profile - background data fields filled out /9	7.5	2.6	60
Edit profile - interest categories filled out? /4	3.5	0.8	28
Forum discussion	3.4	1.1	17
Categories of content	3.4	2.7	37
Articles main	2.6	1.7	45
Article	2.6	2.1	71
Profile content	2.6	1.6	26
Forum discussions recommendations (Forum main page)	2.5	2.1	5
Is this a useful recommendation?	2.2	2.2	11
KB main	2.1	1.2	30
Rating	2.1	1.5	36
Profile - recommendations hovered over/viewed	2.0	1.4	10
Profile - recommendations clicked	2.0	1.4	10
Information bubbles	2.0	1.4	4
Articles recommendations (on Articles pages)	2.0	1.0	14
About Us	1.8	0.8	18
Language selection	1.8	0.5	7
KB article	1.7	0.9	20
Blog main	1.7	1.2	5
KB recommendations (on KB pages)	1.5	0.5	9
Adapting text size	1.5	0.7	3
Adapting text color	1.5	0.7	3
Blog post	1.5	1.0	6
Is this a useful recommendation? - within a content	1.3	0.5	8
Forum main	1.3	0.6	4
Edit Profile	1.3	0.7	13
Home page	1.3	0.5	23
What did you think about the following content?	1.3	0.5	5
Commenting	1.3	0.5	5
Emotion Tool	1.1	0.4	8
Red rectangle in user profile	1.1	0.4	9
Filtering recommendations on profile	1.0	0.0	2
Profile - users followed	1.0	0.0	2
Profile – activities	1.0	0.0	3
Adaptive storyline content	1.0	0.0	5
Chatroom	1.0	0.0	2

2. Effect of emotions

The participants mainly experienced interest and fear at login, while the intensity of shame and disgust was the lowest. During-use emotions seem to follow a similar trend - *interest* was the *most intense*, while shame and disgust were on average not felt at all. During website use, the intensity of *surprise* and *joy increased*. The *positive emotions* – interest and joy - as well as surprise, were *felt more intensely* than the negative emotions. Moreover, the intensity of *guilt, anger, sadness* and *fear decreased* during website use. This suggests that users *enjoyed interacting with the website*, and that the website was more likely to *evoke or increase intensity in positive emotions*, while decreasing the experience of negative emotions.

Correlations: Correlation tests were applied only to the 9 emotions reported at login. Corrections were applied to the α , due to multiple comparisons of 9 emotions and 50 content/features. There were *no significant correlations*. The only correlations discovered were those at the 0.05 level of significance:

- *Interest* and Recommendations on user profile page (clicked or viewed) ($\rho = -.968, p = 0.007$);
- *Interest* and About Us ($\rho = -.814, p = .014$).

Therefore, the longitudinal data imply that emotions experienced at login do not necessarily influence user's choice of features to interact with. However, given the small number of cases and a large dimensionality of the dataset, these results should be interpreted in combination with the survey data results and the other findings.

Appendix L

Usefulness of individual personalisation features

This appendix presents the findings for RQ 2.1.1, specifically addressing how users evaluated the individual PORT website personalisation features in terms of usefulness (H 2.1.1 1). Moreover, the appendix reports on the usefulness of emotion-based features (H 2.1.1 2).

L.1 H 2.1.1 1. People affected by cancer perceive personalisation features they are offered on a cancer website as useful.

The **H 2.1.1 1** hypothesis was *supported* by data in all four studies (Study 2 – Study 5). The results for the factor *usefulness of personalisation features* were reported on in Chapter 7 (Section 7.3).

Furthermore, Wilcoxon signed rank tests were applied to establish whether the usefulness of individual personalisation features differs significantly than a neutral rating. In Study 3 and 4, the median values for the level of agreement about the perceived usefulness of each of the 33, i.e. 32 (respectively), individual personalisation features were significantly higher than 3 ($p < 0.005$ for each of the features tested). This was further shown by descriptive statistics: in Study 3 for each of the 33 features, mean values > 3.39 ; in Study 4 for each of the 32 features mean values were greater than 3.3.

In Study 2, users were *neutral* about the usefulness of only three features: *greeting with user's name* ($p = .513$), *adapting text colour* ($p = .951$) and *personalised e-mail notifications* ($p = .133$). In Study 5, participants were for the majority part *neutral* about the usefulness of the following features: greeting with username; adapting text colour and text size; tailoring website background; red rectangle notifications; reporting emotions at rating; forum discussions' recommendations; the feature "What did you think about the following content?".

Figures A.31 – A.34 show the *distribution of usefulness ratings for the individual PORT website features and content*, based on the data obtained in Study 2 – 5, respectively. As denoted by the labels, the features were categorised into seven groups, based on their functionality and classifications proposed in [77, 80], as follows: recommendations (R), knowledge and awareness infrastructure (KAI), support for customer search (SCS), user profile / member information (UPI), support for user decisions (SUD), adaptive navigation (AN), and adaptive presentation (AP).

It should be noted that Study 4 used an extended scale to measure the usefulness of personalisation features. In addition to expressing whether they 1 - *strongly disagree* to 5 - *strongly agree* that a feature was useful, participants could also state they *did not notice a feature* (option 6). For graphical and descriptive data representation, all six response options were taken into account. However, in computing the factor *usefulness of personalisation features*, the cases with value 6 were treated as a missing response, i.e. were ignored.

L.1.1 Top ranked useful features

The findings of the four studies which indicated the *top ranked useful features* were outlined in Chapter 7 (Section 7.3). Additionally analysed was ***website interaction data*** collected from March 2016 onwards on the PORT website with emotion-based personalisation (Phase III and IV version). User feedback to the question ***Is this a useful recommendation for you?*** was explored *seeking to understand whether the actual content recommendations on the PORT website were found useful*. As explained in Chapter 5, content recommendations on PORT website are provided within the user profile page, and on pages of different content types – articles, forum, blogs, and knowledge base.

The dataset contained 101 instances, defined by the variables: username, date and time, location (web page) of the recommendation, content type of the recommendation, title of the content, and response Yes/No to *Is this a useful recommendation for you?*. Overall, the ***content recommendations*** on PORT website *were found significantly useful* ($\chi^2(1) =$

6.2, $p = .013$). Binomial test showed that the probability of the two responses - Yes and No - was significantly not equal ($p = .017$). 62.4% of users selected Yes, thereby claiming that the personalised content recommendations (on the different pages of the website) were useful. The results indicated that there was no significant correlation between the location (website page) where the recommendation was displayed and whether or not the recommendations was considered useful (usefulness response) ($\chi^2(4) = 6.9, p = .142$).

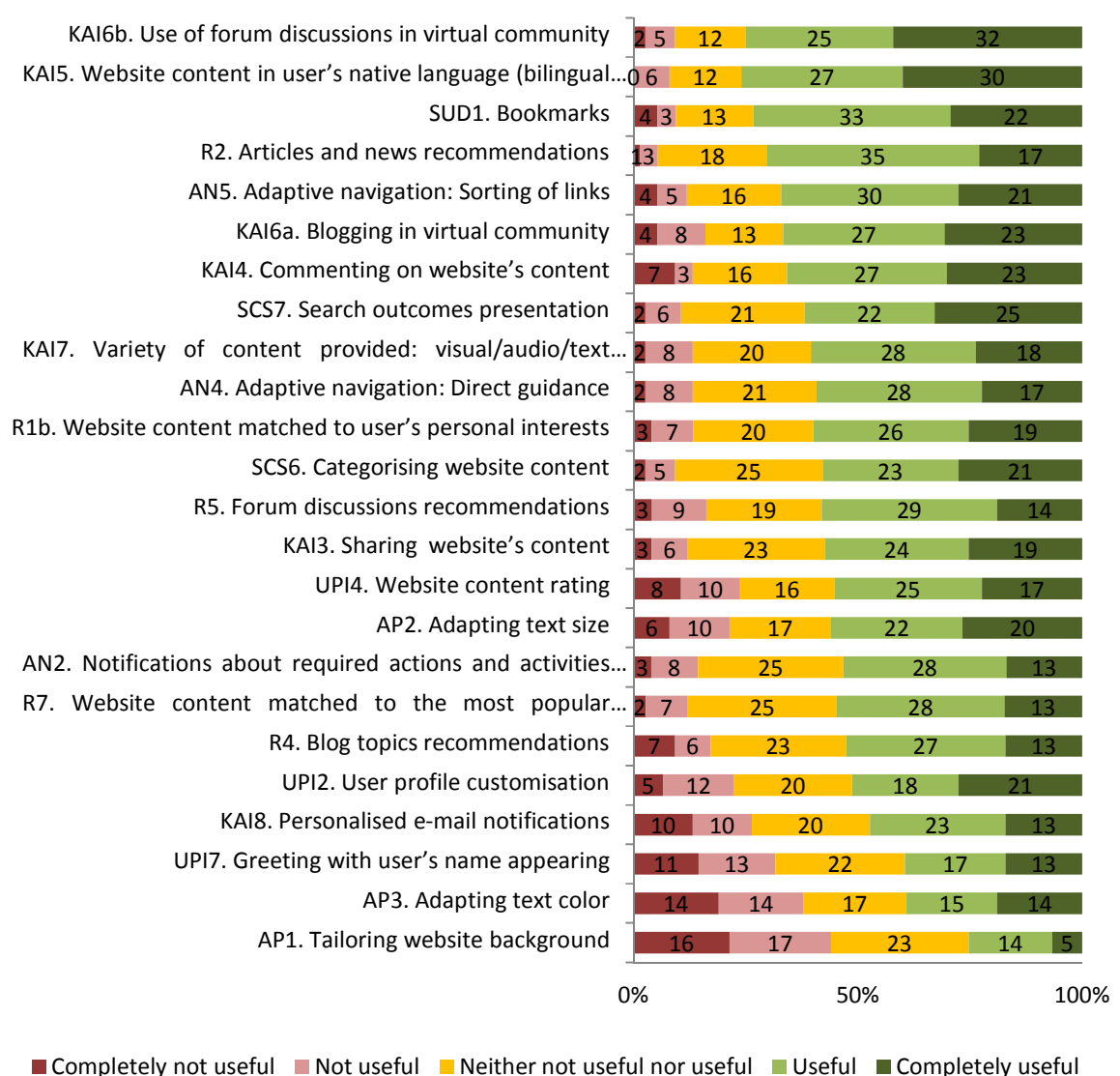


Figure A.31. Study 2 - Usefulness of individual personalisation features

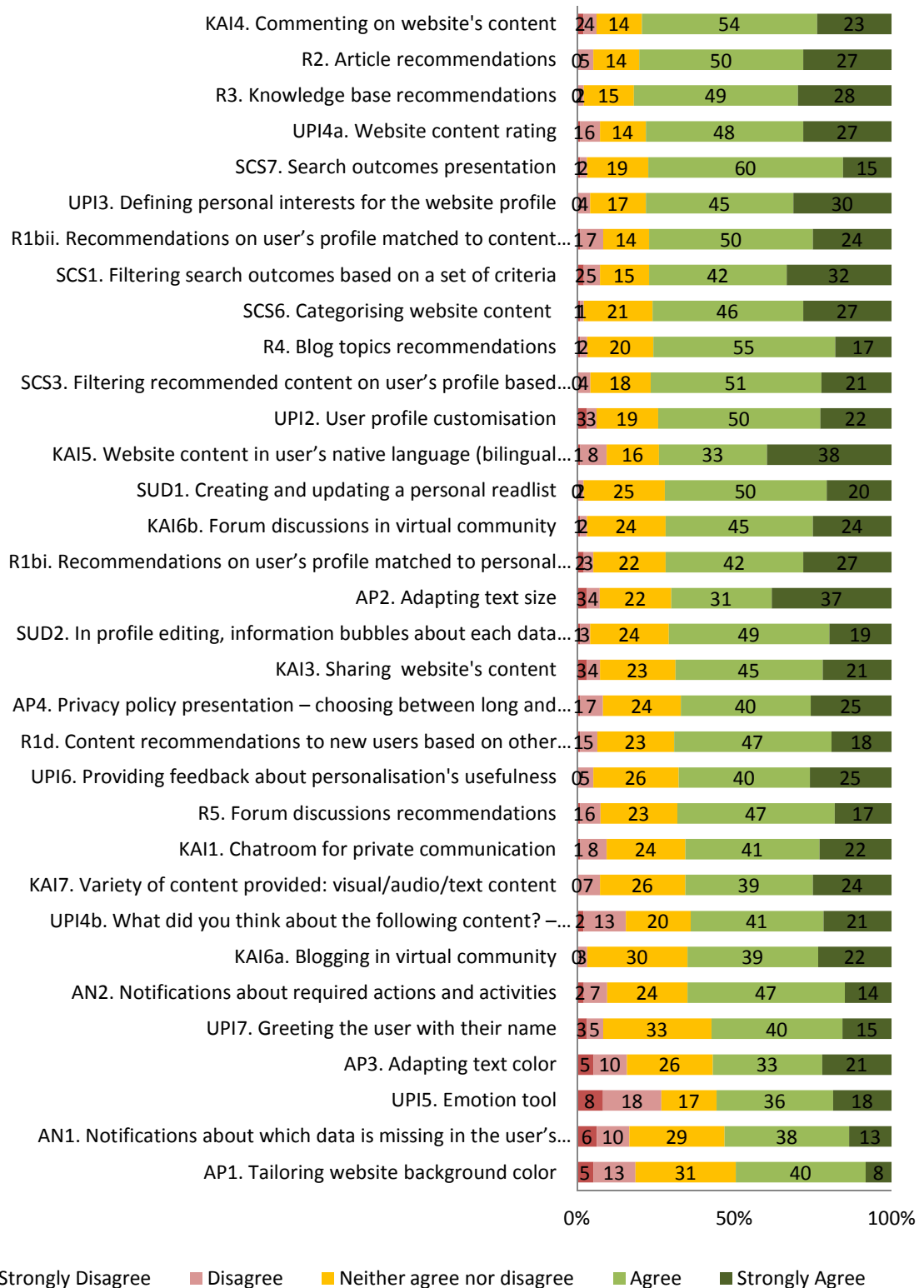


Figure A.32. Study 3 - Usefulness of individual personalisation features

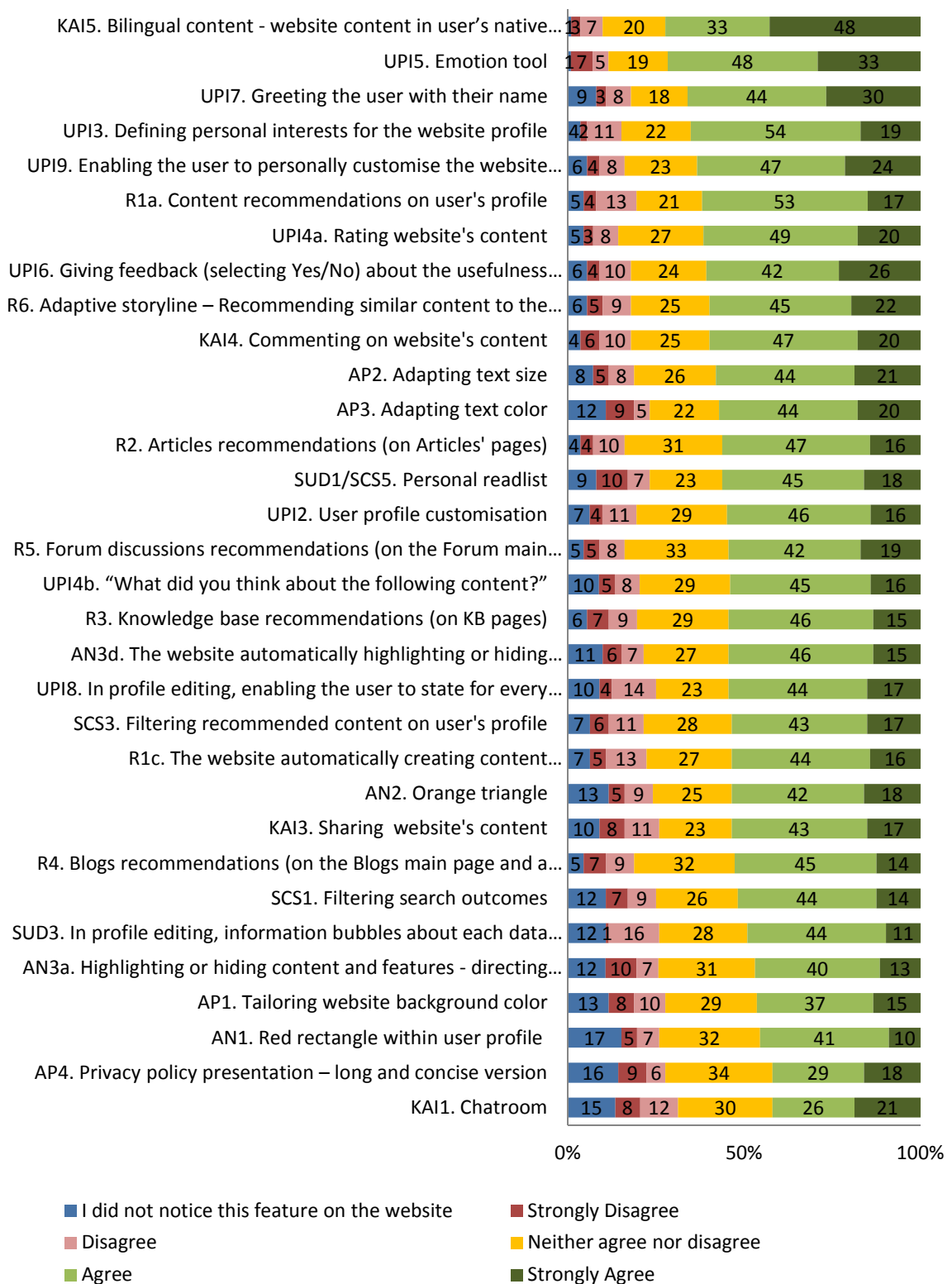


Figure A.33. Study 4 – Usefulness of individual personalisation features

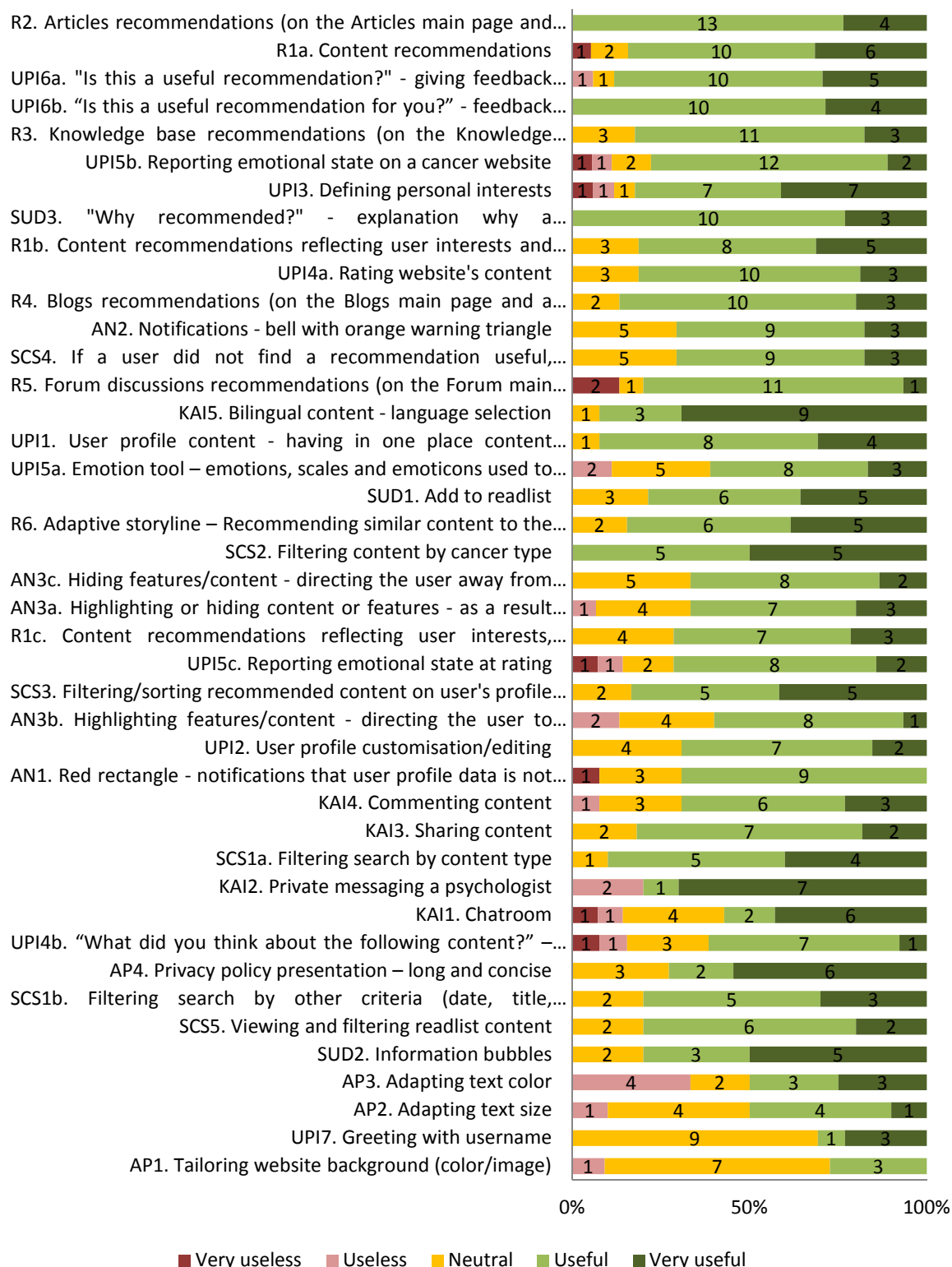


Figure A.34. Study 5 - Usefulness of features and content on PORT cancer website

L.1.1.1 Longitudinal study

In Spring 2016 a **longitudinal study** was carried out, in addition to the Study 4 surveying and experiments. The longitudinal study focused on user interactions with the PORT website with emotion-based personalisation (Phase III version). The methodology and findings of the longitudinal study are explained in greater detail in Appendix K and Chapter 4 (Section 4.3.3.1). Based on this study, *users who are familiar with the personalised PORT website (i.e., repeat visitors), most frequently viewed **articles** and **knowledge base related content***. The website features they *most frequently used* are:

- user profile customisation
- giving feedback about recommendations via *Is this a useful recommendation?*
- *content recommendations* – on *user profile* page, and specifically for *articles* and *forum discussions*
- *rating* content
- adding content to their *readlist*
- *content categories*

Therefore, in long-term interaction with the website, users most frequently use the features and content they also find the most useful, as shown by the main research findings presented in the previous section.

L.1.1.2 Study 5: Interview findings

Study 5 interview data gives additional support to findings on the most useful features. The interview procedure and questions are presented in Appendix J. Here provided are extracts from the interview transcript with the two interviewees: IntTHS – a young cancer survivor; and IntLA – a current cancer patient. Both interviewees have used the latest version of PORT website over a certain period of time, i.e., can be considered repeat visitors.

IntTHS pointed out the importance of enabling a user to ***define their cancer-related interests***. He claimed this to be the most useful feature for him on a cancer website. Next,

in the order of usefulness, for him are the features: content recommendations, Emotion Tool - reporting emotions and giving feedback about recommendations. He stated the following:

*To me the most useful was the website feature that enabled me to **define my interests**. Then second ranked would be what the website **recommends** me, especially **articles**, and **recommendations on my profile**. Then on third place would be emotions, **reporting emotions** to receive website recommendations. After that I would say being offered additional things [most popular content, latest articles], but not in the forefront. Also that I can decline a recommendation, I can choose it or not [via the feature **Is this a useful recommendation?**]. I also liked that if I read a recommended content, and I said I liked it, that it recommends me additional similar things [adaptive storyline].*

The interviewee IntLA frequently user and liked the feature *Why recommended?*. She claimed this to be a useful feature, and stated:

And maybe then you ask yourself – Why were these specific articles recommended to me? Then you see – Oh! That is because at that moment I felt negatively. That is why I think it is convenient to have this [Why recommended?] offered. It is not too prominent, it is not distracting. You can ignore it, or pay a little more attention to see it, and understand why it is there.

The interview findings further indicated that the features and content a user will choose to interact with depend on who they are visiting the website for and which visit to the website it is. At the **first visit** to the website, particularly if searching information for someone else, a user would look for factual content, thereby visit and read **Knowledge base content**, and especially use the **filter** for filtering content **by cancer type**. Moreover, at the **first visit**, users are likely to also visit **Articles**, but less likely to explore **Forum** content and **Chatroom** visitors and conversations.

As IntLA explains:

[T]he two main steps I take. I first review articles, then I go to the Knowledge base to obtain more in-depth information about the topic. The focus at the moment is more on

informing oneself, on articles, to read as much as possible. Later on it will be on support, keeping track of everyone's progress...Based on that the focus will change. I looked at the forum a few times. I think that would be something I would join later on.

After becoming more familiar with the website, at a **third or later visit** to the website, a user would visit the **Profile page** to view the content provided there, particularly to view the **content recommendations**, as they would be *expecting the website to have gathered sufficient information about their content preferences, interests and emotions to be able to give them relevant recommendations.*

L.1.2 Features users were neutral about

Even though the majority of the evaluated features in the four studies carried out here were considered useful, there were a few features that were the bottom ranked in terms of usefulness. Generally, these features were not rated useless (apart from Tailoring website background in Study 2), but rather users were indifferent or neutral on the matter of their usefulness for a cancer website. The bottom ranked features were listed in Chapter 7 (Section 7.3).

Interestingly, each of the features in Study 4 (Figure A.33) was reported as *not noticed* at least in one instance. The features participants most frequently reported not to have noticed on the website were: red rectangle within user profile, privacy policy presentation, and chatroom. *These were the PORT website features which were not displayed on the most popular web pages or most visible website's parts.* They required a more thorough exploration of the website, including opening website's sub-links and engaging with the options provided on the user profile page. It is possible the parts of the website these features were offered on were not opened within the limited usage time.

Based on the **longitudinal website usage data**, users have very rarely used or not at all the majority of the bottom ranked features, including: *tailoring background color, forum discussions, greeting with the username.* Other features these repeat visitors have not

interacted with are: *filtering search outcomes, adapting the presentation of the privacy policy and sharing a specific content.*

L.1.2.1 Study 5: Interview follow-up on the least useful features

The features extracted from Study 4 **interview data** (Appendix I) and Study 5 (Experiment 1) **user comments**, have been included in the two lists of most useful and least useful features. Study 5 **interviews** (Appendix J) followed-up on these findings, whereby cancer-affected, long-term, users of the PORT website were inquired about why the identified features were perceived the most or the least useful.

Hence, the interviewee IntLA claimed she found the majority of the bottom ranked features to be *very useful for her*. For example, both of the interviewees had positive impressions about the feature *What did you think about the following content?*. IntLA stated:

This is very practical; that the portal remembers what you viewed and reminds you to rate it. So I think this is very useful, when I have read a few articles, but have not at that moment rated them, that it reminds me ‘What did you think about this?’.

While IntTHS claimed:

How else is it going to make new recommendations for me if it does not know what I am interested in. Maybe they [other users] were not aware what it is used for. [...] I don’t understand why they did not think this feature was useful, since this is the essence of the website.

Furthermore, IntLA especially defended and expressed the need for features that were repeatedly ranked the least useful, such as *tailoring website background colour and adapting text colour*. IntLA claimed:

But for me, you see, that [tailoring background colour] was really convenient. Because I use the computer a lot, and when there is too much whiteness, it bothers me a lot. Then I appreciate it greatly when there is an option for me to change the background, so that it is not too striking.

[F]or me that [adapting text colour] is very important. Especially, to reduce the contrast. For example, when the background is shiny white, and the text is black, that is very striking for me and bothers me greatly. Then I try to adjust the text to grey.

She was also mainly positive about the feature *greeting with username*. IntLA stated:

[F]unctionality-wise it might not be as useful, but it is nice when you are welcomed with a greeting. So, I like it. For me, it is more a positive feature.

IntTHS further pointed out the importance of the *red rectangle notifications* on the profile page:

[S]ome people might not be aware that they can edit their information. This way the website informs the user they can change their data... This thing, I think, is very important.

Moreover, when asked whether there is any part of the website they would rather were not shown, or that irritated them, both interviewees stated they would not exclude any of the features from the website. As IntTHS said: *The website offers me everything, but nothing is compulsory.*

L.2 H 2.1.1 2. Personalisation features recommended to users based on their emotions are the features users rated the highest in terms of usefulness.

This hypothesis was tested only on Study 4 and Study 5 data, as these studies evaluated the PORT website with emotion-based personalisation. The findings *partially supported* the **H 2.1.1 2** hypothesis, as some of the emotion-based features were considered by users among the most useful website features.

The following features on the Phase III PORT website version (evaluated in Study 4) were adapted or personalised to user emotions:

1. Content recommendations on user profile page
 - The website automatically creating content recommendations for the user (based on user interests, ratings, emotions, and other behaviour on the website)

2. Recommendations on the main pages of different content types – forum, article, knowledge base, blog
3. Emotion Tool (appearance – emotions, scales and emoticons used to report affective state)
4. Highlighting or hiding content and features - directing the user to specific website parts based on their emotions
 - Highlighting features/content - directing the user to specific website parts based on their emotions
 - Hiding features/content - directing the user away from specific website parts based on their emotions

All the above listed features were also evaluated on Phase IV PORT website (in Study 5), as well as two additional features:

1. Reporting emotions at rating or in general on a cancer website
2. *Why recommended?*

L.2.1 Study 4 and Study 5: Survey findings

All the emotion-based features evaluated in **Study 4** had the highest median usefulness of 4 (agreement about usefulness of the feature). For comparison purposes, mean values were also used. Based on the mean values, two of the top ten most useful features were the emotion-based features – *Emotion Tool* (3rd placed) and *content recommendations on the profile page* (10th placed). Recommendations on the pages of the different content types were also highly useful, among the top 16 features.

Interestingly, one of the 17 most useful features was *website automatically highlighting or hiding features from the user (based on user emotions)*. However, the same feature, i.e., functionality, expressed as *highlighting or hiding content and features - directing the user to specific website parts based on their emotions* was the bottom rated feature for usefulness (even though still considered useful based on the mean value = 3.39 and

median = 4). This could imply that the wording of features potentially influenced user opinion about the feature.

Moreover, *user comments* collected in **Study 4** indicated that participants had somewhat a negative attitude towards reporting emotions on the Phase III PORT website, and the emotion-based services. Hence, Par1 claimed: *I feel that reporting emotions so often would be tedious. I am not so sure how honest I am ever being with myself when I report emotions.*

Similarly, Par2 said: *“My emotions throughout the experiment didn't change very much (in only about 20 minutes). If I'd had a bad day or some emotional experience before using, it might have been more interesting to see how the system might have adapted to my mood.”* While participant Par3 believed that the *sentiment analysis evaluation metrics* were too complex.

Study 5 user comments indicated that the Emotion Tool was considered slightly boring, particularly when automatically popping up on every content rating. Some users believed it had too many emotions to report on. Other users suggested providing *“an easy access button that offers you to record your emotions”* instead of the tool automatically appearing. However, the fact that they did not notice that a button/icon for the Emotion Tool is already present on the website, implies a very high likelihood that if it were left to the users to remember to click on the Emotion Tool button, they would very rarely report their emotions. This argument is further supported by Study 5 interviewees who expressed they would likely not report their emotions in that case. The interviewees believed that the current automatic appearance reminds them to report emotions, and as long as they are offered a chance to choose to use or close the Emotion Tool, they preferred the current functionality.

The *emotion-based features* evaluated in **Study 5** were not considered the most useful. Nevertheless, *all the emotion-based features had a median value of 4*, implying that all were *perceived useful*. Mean usefulness values showed two emotion-based features – *Article recommendations* and *Why recommended?* – were among the 13 most useful features. *Emotion-based content recommendations* were considered highly useful, placed

among the top 28 features. However, *content recommendations* that did not reflect the emotions, but only *user interests and content preferences*, were perceived more useful and were ranked on the 17th place.

As in Study 4, there are interesting discrepancies in perceptions about highlighting and hiding features. However, in Study 5 it is to be assumed that users understood the feature given that the study's experiments specifically instructed how to go to the feature and use it. It appears users considered more useful *highlighting or hiding content or features – based on emotions* (mean = 3.8, median = 4) and more interestingly *hiding features/content - directing the user away from specific website parts based on their emotions* (mean = 3.8, median = 4), than being guided to website features via *highlighting features/content - based on emotions* (mean = 3.53, median = 4).

Furthermore, based on the ***Study 5 interaction experiment*** (Experiment 2), some of the emotion-based features were among the most frequently used features on the PORT website. The *second most clicked on* feature on the website were the *highlighted features*, i.e., *adapted* to guide user attention to them. The *Emotion Tool* was one of the five most frequently interacted with features. *Article recommendations* were also frequently clicked on. However, *emotion-based recommendations on the profile page* were not clicked on at all, despite the fact that users did frequently visit their profile page.

L.2.2 Study 5 Interview: Follow-up on emotion-based features

The Study 5 interview with cancer-affected long-term users of the PORT website also addressed the findings related to the emotion-based features. Appendix J explains the interview procedure in greater detail. This section provides excerpts from IntLA and IntTHS interviewees' responses.

IntLA claim that when she was in a *negatively valenced affective state*, she first viewed *articles*, especially *article recommendations*. She would then *open a few articles*, and *give feedback about the usefulness* of recommendations, in order to remove those that do not interest her.

When visiting her *profile page*, she also reviewed the *content recommendations* and noticed the effect of emotions on them. IntLA stated:

I purposely clicked on 'Why recommended?' to see what that is. And then it reminded me that it is when you click various combinations or just one of the emotions, that based on that it lists out the recommendations...[Y]ou see an article, and ask yourself 'Why did I even open this?... oh, yes, it is because I rated it based on such and such emotion'.

Given that findings indicated that *content recommendations on the profile page* were rarely visited, interviewees were asked whether the recommendations are noticeable, whether they believe these should be placed elsewhere to be more visible.

IntLA stated:

I think it is OK. It is not too far down. I see there is something else there, so I scroll down, and I see it [content recommendations]...[I]t is not a must to change its location, because it is not hidden. It can be noticed.

IntTHS believed that what influenced whether a user explored their profile page depended on how cancer affected them, and stated:

Someone who has faced cancer, or whose family member had cancer, when they see the recommendations, they will go to their profile to personalise it... A person who visited the website simply to inform themselves, or they have a friend who has cancer, they might want the website to offer them all about cancer, so that they read in general what cancer is.

Moreover, he confirmed the possibility that users simply did not notice the recommended content on their profile page, either because they did not visit their profile, or because other features and content were listed before the recommendations. IntTHS stated:

Perhaps users just saw – Latest content – and started reading that. Maybe they did not even grasp that anything is offered below. Because someone might go like this

[the interviewee demonstrates opening the profile page and scrolling half way to the list of Latest content and stopping before the Recommended content title].

The interviewees also discussed the website's **Emotion Tool** and **being asked to report emotions** on a cancer website. The interviewees claimed *the use of the Emotion Tool was smooth* and that it was *easy to report emotions* with the scales and items used. However, this is the case when a user becomes accustomed to the fact that the Emotion Tool appears on certain activities on the website, when they are aware why emotions are collected and see the results in content and feature adaptation.

IntLA stated:

[W]hen I first saw emotions to appear at login [Emotion Tool], I thought it would irritate me. However, it has not so far. I got used to it. A few of the first times, it was a surprise to me. But then I saw it is related to my activities on the website. Depending on what I do, I know – ok, it will now ask me about emotions...[Y]ou associate. I rated an article, so I will probably now receive an inquiry about my emotions, which I can ignore, or fill out. Therefore, it became the expected thing for me. It is sometimes good to stop and think – why did I read this specific article, what am I feeling at this very moment?

Interviewees were further asked for their opinion why a user who came to the website knowing it offers emotion-based personalisation, would have a *negative attitude toward reporting emotions on a cancer website*.

IntLA stated:

Perhaps because it resembles pop-ups. People are generally bored with pop-ups, and they look for all possible ways to remove them. When I first started using the website, it surprised me a little, because I forgot that it is offered. So, had you asked me then, I would probably also say I associate it with something negative. However, later on, the more I used the website, and when I realised it is connected to what I see on the website, that what I receive in the results [recommendations], then it changed

towards more positive [perception]. On a scale of 1 to 5 I would give it a 3 or 3.5, based on my so far perception.

Similarly, IntTHS stated:

[E]motions, when they pop-up when I read something, I saw that I can choose to report or not. However, I think it is important to do that.

If these were users from our region [B&H], I think the main reason is that it annoys them...because it inquires the user about something. And secondly, because they do not understand the essence of the feature. They do not understand that by reporting emotions, the whole website will change for them, the recommendations on the website, everything will change, for their benefit. I think when someone reads a piece of content and then emotions appear they think – What is this now? They do not understand that by reporting emotions when rating that article, in future visits a similar article will be shown... I think the majority of people might not understand this, maybe because they have not used the website long enough, or because they did not understand its purpose, or because it is something new for them, or because it constantly asks them how they feel... I rate something and it asks me how I feel, and I don't understand why it asks me again if I have already stated that at the beginning [at login]. In my opinion, having the Emotion Tool is good. It is positive because it will facilitate my search of the website.

IntTHS further explained that it might depend on the type of the user and intent to use the website over a longer period of time, whether they will perceive ***emotion-based personalisation useful***. He stated:

I think the main thing here is why the user visited the website in the first place. Did they come to the website with a particular problem or just to raise their awareness about cancer. In the latter case, they can open the website, but they might not be interested in emotions, because he might want to be offered everything whenever he comes to the website. Someone who comes to the website with a specific illness, they will want the website to ask them to define an interest or select an emotion, so that the

website would offer them the same the next time they come. Because, if they are facing a problem, they will be visiting the website more frequently and using for a longer period. Therefore, I think this type of a website would benefit more those who came to it with a certain cancer-related problem...

Unlike the Study 4 and Study 5 survey participants, the interviewees did not consider the **Emotion Tool** complex for use. Moreover, they believed users can reflect on their affective state and self-report emotions.

IntLA said:

[Emotion Tool] is very simple. You can see something like this in any questionnaire, anywhere online. Rating on a scale where you select the lowest or the highest rating or something in between.

I think it is possible to report...not a completely precise affective state...but relatively well. Perhaps, people are put-off by having to stop and think a little at that moment about how they feel.

IntTHS stated:

I don't see why it would be complex for use. For example I feel interest, I will choose interest, and four [intensity]...and ok, I click Save. That is it.

Moreover, with respect to the **emotion-based adaptation** that appears on the PORT website in the form of feature and content highlighting and hiding, the interviewees both claimed they noticed the adjustments to the website appearance. They found them useful and particularly liked the choice of green colour for highlighting in contrast to the other website colours.

IntLA claimed:

This colour [green used for highlighting] is not too striking. And the contrast is nice. When you open the website, perhaps you do not notice it immediately, but when you

look more attentively, you notice that there is something different, and then maybe you ask yourself – Why? Oh! That is because of the emotions.

Also those squares...they were framed in green colour [recommendations on different content pages]. That I also noticed.

IntTHS stated:

I like it that the website uses colour to highlight that what interests me. For me it is nicer that it uses colour, rather than for example check marks or similar... When it is green like this, I know it is something for me... I think these changes are noticeable enough, also because the colours are positive. [W]hen I go to Articles, this part that is encircled in green [green frame around article recommendations], because it might interest me more so it shows it in green.

However, IntTHS also believed that a first time user might not notice the changes; that they might think it is just the default state of the website. On the other hand, a user who comes to the website more often, reports different discrete emotions, and hence notices changes and might “wonder why suddenly something else was shown in green, and will want to click on it”.

L.3 Summary

Overall, the personalisation features offered on the PORT website, are perceived useful. There are certain features – e.g., related to adapting the font or website background - which some users were indifferent about. The opinions about the emotion-based features were divided. Nevertheless, there are indications that it depends on the user type – whether a user is a first time, infrequent user, or a repeat visitor, and whether they are facing a cancer problem themselves. First time users might not be aware of the benefits of reporting emotions. On the other hand, people fighting cancer intend to use the website more frequently, and thus become familiar with how emotion-based personalisation leads to more personalised recommendations and navigation support.

Appendix M

Correlations between pre-use emotions and usefulness of individual features

This section presents findings that responded to the RQ 2.1.4 - *Do emotions influence which content and features users will perceive useful, or choose to interact with on a personalised cancer website?* First presented are all the correlations for the discrete pre-use positive emotions, followed by those for the discrete pre-use negative emotions.

M.1 H 2.1.4 6a. Discrete pre-use positive emotions positively influence how useful each individual personalisation feature is perceived.

The following list shows associations for discrete pre-use positive emotions which were significant at the 0.05 significance level. The associations found in more than one study are presented in bold font.

- **Interest** and **User profile customisation** (Study 5: $r = .575$, $p = .04$; $X^2(8) = 17.06$, $p = .029$; Somers' $d = .422$, Gamma = .628, $p = .059$; Study 4: $r = .275$, $p = 0.005$) and related feature - *enabling the user to personally customize the website by updating their preferences and personal data* (Study 4: $r = .206$, $p = 0.037$)
- **Interest** and **Bilingual content/selecting language** (Study 5: $r = .817$, $p = .001$; $X^2(8) = 21.67$, $p = .006$; Somers' $d = .563$, Gamma = 1.0, $p = .001$; Study 4: $\rho = .277$, $p = 0.004$; Study 3: $X^2(16) = 26.39$, $p = 0.049$; Somers' $d = .101$, Gamma = .143, $p = .223$)
- **Interest** and **Adapting text colour** (Study 4: $X^2(16) = 28.86$, $p = 0.025$; Somers' $d = .065$, Gamma = .092, $p = .433$; Study 2: $\rho = .248$, $p = .037$)
- **Interest** and **User profile content** (Study 5: $X^2(8) = 16.49$, $p = 0.036$, Somers' $d = .246$, Gamma = .429, $p = .285$)
- **Interest** and "What did you think about the following content?" (Study 5: $X^2(16) = 31.57$, $p = .011$)

- *Interest* and Filtering search outcomes by content type (Study 5: $r = .643$, $p = .045$)
- *Interest* and Filtering content by cancer type (Study 5: $r = .75$, $p = .012$)
- *Interest* and Tailoring website background (Study 2: $\rho = .234$, $n = 73$, $p = .046$)
- *Interest* and Adapting text size (Study 2: $\rho = .251$, $p = .033$)
- *Interest* and Knowledge base recommendations (Study 5: $r = .676$, $p = .003$)
- *Interest* and Forum discussions recommendations (Study 2: $\rho = .247$, $p = .038$)
- *Interest* and Blog topics recommendations (Study 2: $\rho = .269$, $p = .021$)
- *Interest* and Content recommendation matched to personal interests (Study 3: $X^2 = 27.23$, $p = 0.039$)
- *Interest* and Emotion Tool (Study 4: $r = .237$, $p = 0.013$)
- *Interest* and Rating content (Study 4: $r = .268$, $p = 0.006$)
- *Interest* and Sharing content (Study 4: $r = .211$, $p = 0.036$)
- *Interest* and Greeting with user name (Study 4: $X^2(16) = 31.75$, $p = 0.011$; $r = .343$, $p = 0.000471$)
- *Joy* and Articles' recommendations (Study 5: $r = .559$, $p = .047$)
- *Joy* and Blog recommendations (Study 4: $X^2(16) = 28.61$, $p = 0.027$)
- *Joy* and Forum discussion recommendations (Study 4: $X^2(16) = 32.49$, $p = 0.009$)
- *Joy* (i.e., *happiness*) and Filtering recommended content (Study 3: $X^2 = 28.44$, $p = 0.005$)
- *Joy* and Highlighting or hiding content/features based on emotions (Study 4: $X^2(16) = 30.14$, $p = 0.017$)
- *Joy* and Rating content (Study 4: $r = .206$, $p = 0.040$)
- *Joy* and Readlist (Study 4: $X^2(16) = 31.31$, $p = 0.012$)
- *Joy* and Greeting with user name (Study 4: $r = .248$, $p = 0.015$)
- *Excitement* and Adapting text colour (Study 2: $\rho = .283$, $p = .017$)
- *Excitement* and Information bubbles in profile editing (Study 3: $X^2 = 32.33$, $p = 0.009$)
- *Calmness* and Readlist (Study 3: $X^2 = 27.82$, $p = 0.006$)
- *Calmness* and Chatroom (Study 3: $X^2 = 30.07$, $p = 0.018$)
- *Awe* and User profile customisation (Study 3: $X^2 = 25.41$, $p = 0.013$)

- *Awe* and Information bubbles in profile editing (Study 3: $X^2 = 24.53$, $p = 0.017$)
- *Awe* and Notifications about user activities (orange triangle) (Study 3: $X^2 = 23.9$, $p = 0.021$)
- *Awe* and Notifications to complete user profile data (red rectangle) (Study 3: $X^2 = 23.69$, $p = 0.022$)

The correlations (at the 0.05 significance level) found between discrete emotions and *website content types* and *other features* are presented in the following list:

- *Interest* and Search functions or Blog search (Study 5: $r = .726$, $p = .008$; $X^2(8) = 16.93$, $p = .031$ (+))
- *Interest* and Articles and news content (Study 5: $r = .591$, $p = .033$)
- *Calmness* and Categorising content (Study 3: $X^2 = 27.99$, $p = 0.032$)

M.2 H 2.1.4 6b. Discrete pre-use negative emotions negatively influence how useful each individual personalisation feature is perceived.

The *significant associations*, at the corrected α , between the discrete *pre-use negative emotions* and usefulness of the *individual personalisation features* are presented in Chapter 7. Additionally, associations were discovered at the 0.05 significance level (correlations in bold appear in several studies), for the following discrete pre-use negative emotions:

- *Surprise* and Knowledge base recommendations (Study 4: $X^2(16) = 26.98$, $p = 0.042$)
- *Surprise* and Article recommendations (Study 3: $X^2 = 24.3$, $p = 0.018$)
- *Surprise* and Blog recommendations (Study 4: $X^2(16) = 28.41$, $p = 0.028$)
- *Surprise* and Forum discussions recommendations (Study 4: $X^2(16) = 36.59$, $p = 0.002$)
- *Surprise* and (website automatically creating) Content recommendations (based on user interests, ratings, emotions, and other behaviour on the website) (Study 4: $X^2(16) = 31.92$, $p = 0.010$; $r = -.199$, $p = 0.048$)

- *Surprise* and Adaptive storyline (Study 4: $X^2(16) = 31.97$, $p = 0.010$)
- *Surprise* and (website automatically) Highlighting or hiding features (based on user emotions) (Study 4: $X^2(16) = 31.80$, $p = 0.011$)
- ***Surprise*** and **Readlist/bookmarks** (Study 3: $\rho = -.334$, $p = .001$; Study 2: $X^2(32) = 46.52$, $p = .047$; Somers' $d = -.059$, Gamma = $-.084$, $p = .518$)
- *Surprise* and Adapting text size (Study 4: $X^2(16) = 30.49$, $p = 0.016$)
- *Surprise* and Tailoring website background colour (Study 4: $X^2(16) = 35.93$, $p = 0.003$)
- *Surprise* and Commenting (Study 4: $X^2(16) = 41.97$, $p = 0.000398$)
- *Surprise* and Giving feedback on the website (Study 4: $X^2(16) = 40.94$, $p = 0.001$)
- *Surprise* and Chatroom (Study 4: $X^2(16) = 28.91$, $p = 0.025$)
- *Surprise* and Privacy policy presentation (Study 4: $X^2(16) = 31.93$, $p = 0.010$)
- *Surprise* and Filtering search outcomes (Study 3: $X^2 = 31.5$, $p = 0.012$)
- *Surprise* and Emotion Tool (Study 4: $X^2(16) = 30.53$, $p = 0.015$)
- *Guilt* and Emotion Tool (Study 4: $X^2(16) = 26.38$, $p = 0.049$)
- *Guilt* and Adapting text size (Study 3: $X^2 = 27.77$, $p = 0.034$)
- *Guilt* and Article recommendations (Study 4: $X^2(16) = 29.34$, $p = 0.022$)
- *Guilt* and Content recommendations matched to personal interests (Study 3: $X^2 = 27.96$, $p = 0.032$)
- *Guilt* and Rating content (Study 4: $X^2(16) = 40.01$, $p = 0.001$)
- *Guilt* and Giving feedback (Study 4: $X^2(16) = 27.27$, $p = 0.039$)
- *Guilt* and Commenting (Study 3: $X^2 = 26.42$, $p = 0.048$)
- *Guilt* and Notifications about user activities (orange triangle) (Study 3: $X^2 = 27.06$, $p = 0.041$)
- *Guilt* and Search outcomes presentation (Study 3: $X^2 = 26.91$, $p = 0.043$)
- *Guilt* and Filtering search outcomes (Study 3: $X^2 = 36.36$, $p = 0.003$)
- *Guilt* and Filtering recommended content on user profile page (Study 3: $X^2 = 30.9$, $p = 0.002$; $\rho = -.293$, $p = .004$)
- *Fear* and Filtering content by cancer type (Study 5: $r = .655$, $p = .04$; $X^2(1) = 4.29$, $p = .038$ (+))

- *Fear* and Filtering recommended content on user profile page (Study 3: $X^2 = 34.51, p = 0.001$)
- *Fear* and Variety of content (Study 3: $X^2 = 22.99, p = 0.028$)
- *Anxiety* and Commenting (Study 3: $X^2 = 36.73, p = 0.002$)
- *Anxiety* and Information bubbles in profile editing (Study 3: $X^2 = 27.08, p = 0.041$)
- *Anxiety* and Rating (Study 3: $X^2 = 27.54, p = 0.036$)
- **Disgust** (and Study 3: *boredom*) and **Adapting text size** (Study 5: $X^2(3) = 10.00, p = .019$; Somers' $d = 1.0$, Gamma = 1.0, $p = .236$; Study 3: $X^2(16) = 34.04, p = 0.005$; Somers' $d = -.307$, Gamma = $-.423, p = .000$; $\rho = -.351, p = .000419$)
- **Disgust** and **Forum discussions' recommendations** (Study 5: $X^2(3) = 15.00, p = .002$; Somers' $d = -.714$, Gamma = $-.714, p = .285$; Study 4: $X^2(16) = 28.87, p = 0.025$; Somers' $d = .058$, Gamma = $.078, p = .699$)
- **Disgust** (and Study 3: *boredom*) and **User profile customisation** (Study 2: $\rho = -.258, p = .027$; Study 3: $X^2(16) = 36.1, p = 0.003$; Somers' $d = -.324$, Gamma = $-.485, p = .000$; $\rho = -.379, p = .0001306$)
- *Disgust* and Sharing content (Study 4: $\rho = -.205, p = 0.047$)
- *Boredom* and Knowledge base recommendations (Study 3: $X^2 = 25.9, p = 0.011$)
- *Boredom* and Adapting text colour (Study 3: $\rho = -.265, p = .009$)
- *Boredom* and Notifications to complete profile data (Study 3: $X^2 = 26.42, p = 0.048$)
- *Boredom* and Chatroom (Study 3: $X^2 = 28.38, p = 0.028$)
- *Embarrassment (i.e., shame)* and Search outcomes presentation (Study 3: $X^2 = 28.48, p = 0.028$)
- *Embarrassment (i.e., shame)* and Content recommendations matched to preferred content (Study 3: $X^2 = 32.02, p = 0.01$)
- *Shame* and User profile customisation (Study 2: $X^2(24) = 41.3, p = .016$; Somers' $d = -.129$, Gamma = $-.164, p = .406$)
- *Shame* and Emotion Tool (appearance) (Study 5: $r = .516, p = .028$)
- *Sadness* and Content recommendations matched to personal interests (Study 3: $X^2 = 33.03, p = 0.007$)

- *Sadness* and Adaptive navigation: Sorting of links (Study 2: $\rho = -.254, p = .03$)
- *Sadness* and Filtering search outcomes (Study 3: $X^2 = 35.05, p = 0.004$)
- *Sadness* and User profile customisation (Study 3: $X^2 = 31.07, p = 0.013$)
- *Sadness* and Notifications about user activities (orange triangle) (Study 3: $X^2 = 28.07, p = 0.031$)
- ***Sadness* and Commenting** (Study 4: $X^2(16) = 28.17, p = 0.03$; Somers' $d = -.031$, Gamma = $-.043, p = .726$; Study 3: $X^2(16) = 26.45, p = 0.048$; Somers' $d = .013$, Gamma = $.021, p = .890$)
- *Anger* and Search outcomes presentation (Study 2: $X^2(36) = 52.3, p = .039$; Somers' $d = -.181$, Gamma = $-.241, p = .113$)
- *Anger* and Notifications about required actions and activities related to user created content (Study 2: $X^2(36) = 56.41, p = .016$; Somers' $d = -.073$, Gamma = $-.097, p = .56$)
- *Anger* and User profile customisation (Study 4: $X^2(16) = 35.92, p = 0.003$)
- ***Anger* and Defining personal interests** (Study 5: $\rho = -.545, p = .024$; Study 4: $\rho = -.206, p = 0.039$)
- ***Anger* and Forum discussions' recommendations** (Study 5: $X^2(6) = 15.92, p = .014$; Somers' $d = -.352$, Gamma = $-.655, p = .113$; Study 4: $X^2(16) = 32.82, p = 0.008$; Somers' $d = -.146$, Gamma = $-.200, p = .193$)
- *Anger* and Articles recommendations (Study 2: $X^2(36) = 64.4, p = .003$; Somers' $d = -.159$, Gamma = $-.243, p = .156$)
- *Anger* and Knowledge base recommendations (Study 4: $X^2(16) = 27.79, p = 0.034$)
- *Anger* and Content recommendation matched to personal interests (Study 2: $X^2(36) = 62.7, p = .004$; Somers' $d = -.117$, Gamma = $-.15, p = .349$)
- *Anger* and (website automatically creating) Content recommendations (based on user interests, ratings, emotions, and other behaviour on the website) (Study 4: $X^2(16) = 34.88, p = 0.004$)
- *Anger* and Content matched to the most popular among other users (Study 2: $X^2(36) = 56.7, p = .015$; Somers' $d = .073$, Gamma = $.100, p = .544$)
- *Anger* and Adaptive storyline (Study 4: $X^2(16) = 35.31, p = 0.004$)

- **Anger and Sharing content** (Study 4: $X^2(16) = 30.34$, $p = 0.016$; Somers' $d = -.132$, Gamma = $-.175$, $p = .258$; Study 2: $X^2(36) = 67.1$, $p = .000274$; Somers' $d = .000$, Gamma = $.000$)
- **Anger and Adapting text size** (Study 4: $X^2(16) = 30.25$, $p = 0.017$)
- **Anger and Bookmarks/readlist** (Study 2: $X^2(36) = 70.4$, $p = .001$; Somers' $d = -.334$, Gamma = $-.46$, $p = .000$; $\rho = -.359$, $p = .002$)
- **Anger and Emotion Tool** (Study 4: $X^2(16) = 28.3$, $p = 0.029$)
- **Anger and Chatroom** (Study 4: $X^2(16) = 27.56$, $p = 0.036$)
- **Anger and Privacy policy presentation** (Study 4: $X^2(16) = 26.36$, $p = 0.049$)
- **Contempt and Notifications about required actions and activities related to user created content** (Study 2: $r = -.238$, $p = .041$)

The correlations (at the 0.05 significance level) found between emotions and *website content types* and *other features* are presented in the following list:

- **Guilt and Forum discussions** (Study 3: $X^2 = 29.89$, $p = 0.019$)
- **Fear and Forum discussions** (Study 2: $\rho = -.239$, $p = .04$)
- **Fear and Blogging** (Study 3: $X^2 = 37.91$, $p = 0.000159$; Phi = $.635$, $\rho = -.113$)
- **Anger and Forum discussions** (Study 2: $X^2(36) = 67.6$, $p = .001$; Somers' $d = -.11$, Gamma = $-.152$, $p = .345$)

Appendix N

Study 5 Classification rules

Table A.7 presents the classification rules discovered from the Study 5 interactions data. The rules with above 60% accuracy are highlighted in dark green colour. Other rules below the accuracy threshold are highlighted in a lighter green shade.

Table A.7. Classification rules for pre- and during-use emotions and website features and content

ID	Feature/content name	Classifier, Correctly classified instances	Rules
1	Language selection	JRip rules, 70% J48 trees, 65%	(Surprise_L <= 0) => Language selection=None (4.0/1.0) (Interest_D >= 4) => Language selection=None (3.0/0.0) => Language selection=One (33.0/7.0) Interest_L <= 1: None (2.0/1.0) Interest_L > 1 Surprise_L <= 0: None (4.47/1.24) Surprise_L > 0: One (33.53/7.76)
2	Notifications bell with orange triangle	JRip rules, 85% J48 trees, 87.5%	(Sadness_D >= 2) => Notifications bell with orange triangle=One (2.0/0.0) => Notifications bell with orange triangle=None (38.0/3.0) OR : None (40.0/5.0)
3	Add to readlist	JRip rules, 92.5% J48 trees, 95%	(Interest_D >= 4) => Add to readlist=One (3.0/1.0) => Add to readlist=None (37.0/0.0) OR : None (40.0/2.0)
4	Emotion Tool	JRip rules, 72.5%	(Disgust_D >= 0) => Emotion Tool=One (5.0/1.0) => Emotion Tool=None (35.0/6.0)

		J48 trees, 67.5%	OR Interest_L ≤ 2 Shame_L ≤ 2: None (11.54/3.54) Shame_L > 2: One (3.46) Interest_L > 2: None (25.0/3.0)
5	User profile	JRip rules, 65% J48 trees, 65%	(Interest_D ≥ 3) ⇒ User profile=One (4.0/1.0) ⇒ User profile=None (36.0/8.0) OR : None (40.0/12.0) =None (40.0/2.0)
6	“What did you think about the following content?”	JRip rules, 90% J48, 90%	OR Surprise_L ≤ 0 Joy_L ≤ 0: One (2.11/0.11) Joy_L > 0: None (2.34) Surprise_L > 0: None (35.56)
7	Sorting/filtering profile recommendations	JRip rules, 90% J48, 92.5%	(Interest_D ≥ 4) ⇒ Sorting/filtering profile recommendations=One (3.0/1.0) ⇒ Sorting/filtering profile recommendations=None (37.0/1.0) OR : None (40.0/3.0)
8	Clicking on highlighted features/content	JRip rules, 55% J48 trees, 50%	=None (40.0/17.0) OR Joy_L ≤ 1: More (15.14/9.38) Joy_L > 1: None (24.86/6.24)
9	Articles and news content	JRip rules, 47.5% J48 trees, 45%	(Interest_L ≥ 4) ⇒ Articles and news content=One (6.0/1.0) ⇒ Articles and news content=More (34.0/18.0) OR Interest_L ≤ 3 Interest_L ≤ 2: More (15.0/8.0) Interest_L > 2 Anger_L ≤ 0 Shame_L ≤ 0: More (8.44/1.44)

			Shame_L > 0: None (4.22/1.22) Anger_L > 0: One (6.33/2.0) Interest_L > 3: One (6.0/1.0)
10	Knowledge base content	JRip rules, 47.5% J48 trees, 37.5%	(Fear_L <= 2) and (Fear_L >= 2) => Knowledge base content=More (5.0/0.0) (Disgust_L >= 2) => Knowledge base content=More (5.0/1.0) => Knowledge base content=None (30.0/13.0) OR Shame_L <= 2 Interest_L <= 3: None (29.54/12.77) Interest_L > 3: More (5.89/2.89) Shame_L > 2: More (4.57/0.46)
11	Home page recommendations	JRip rules, 57.5% J48, 52.5%	(Surprise_L <= 0) and (Joy_L >= 1) => Home page recommendations=More (2.0/0.0) => Home page recommendations=None (38.0/14.0) OR : None (40.0/16.0)
12	Welcome message	J48 trees, 95%	: None (40.0/2.0)
13	Search functions	JRip rules, 85%	=> Search functions=None (40.0/6.0)
14	Font/text color adapting	J48 trees, 97.5%	: None (40.0/1.0)
15	Editing/tailoring profile	JRip rules, 77.5%	=> Editing/tailoring profile=None (40.0/8.0)
16	Defining interests	JRip rules, 80%	=> Defining interests=None (40.0/7.0)
17	Information bubbles (i)	J48 trees, 95%	: None (40.0/2.0)
18	Tailoring background (color or image)	J48 trees, 90%	: None (40.0/4.0)
19	“Is this a useful recommendation for you?” - within content	JRip rules, 97.5%	=None (40.0/1.0)
20	Rating content	JRip rules, 85%	=> Rating content=None (40.0/4.0)
21	Reporting emotions at rating	JRip rules, 85%	=> Reporting emotions at rating=None (40.0/4.0)
22	Article recommendations	J48 trees, 87.5%	: None (40.0/5.0)
23	“Is this a useful recommendation for you?” at recommendations	J48 trees, 92.5%	: None (40.0/3.0)
24	Categories of content	J48 trees, 60%	: None (40.0/14.0)
25	Commenting content	J48 trees, 97.5%	: None (40.0/1.0)

26	Knowledge base recommendations	JRip rules, 80%	=None (40.0/8.0)
27	Chatroom	JRip rules, 82.5%	=None (40.0/5.0)
28	Contacting a psychologist	JRip rules, 92.5%	=None (40.0/3.0)
29	Font/text size adapting	JRip rules, 95%	=None (40.0/2.0)
30	Forum content	JRip rules, 77.5%	=None (40.0/6.0)
31	Forum recommendations	JRip rules, 97.5%	=None (40.0/1.0)
32	Blogs	JRip rules, 80%	=None (40.0/7.0)
33	Create blog	JRip rules, 97.5%	=None (40.0/1.0)
34	Blog recommendations	JRip rules, 95%	=None (40.0/2.0)
35	Clicking on hidden features/content	JRip rules, 95%	=None (40.0/2.0)
36	Red rectangle notifications	J48 trees, 95%	: None (40.0/2.0)
37	“Why recommended?” explanation	J48, 97.5%	: None (40.0/1.0)
38	Viewing and filtering readlist	JRip rules, 92.5%	=None (40.0/3.0)
39	About Us	JRip rules, 60%	=None (40.0/13.0)
All instances were equal to None (40.0/40.0) for the following features and content: Content recommendations - interests and preferences; Content recommendations - interests, preferences, and emotions; Blog search; Forum search; Sharing content; Filtering by cancer type; Adaptive storyline; Privacy policy content; Privacy policy presentation – full or concise; Filtering search by content type; Filtering search by other criteria			

Appendix O

Final emotion-based adaptation rules recommended for implementation on cancer websites

This section presents the complete set of emotion-based rules for adaptation of cancer website features and content. The first subsection lists the rules that were implemented on latest version of the PORT website, and were evaluated and supported by Study 5 findings. The second subsection presents other emotion-based rules which were extracted from significant correlation findings and highly accurate classification rules discovered from website interaction data in Study 4 and Study 5. As such, the second group of rules is also recommended for adoption on cancer websites.

O.1 Confirmed Phase IV emotion-based adaptation rules

The complete list of Phase IV emotion-based adaptation rules is provided in Appendix F. This section highlights the set of emotion-based adaptation rules that were implemented on the last version of the PORT website (Phase IV version), as part of the A3 algorithm for website adaptation to user emotions (Chapter 5, Section 5.3.2). The rules were confirmed by:

- Study 5 findings of significant correlations (at the corrected α and 0.05 sig. level) between each discrete emotion and usefulness of personalisation features (Chapter 7, Sections 7.6.3 and 7.6.4)
- and Study 5 classification rules linking login and during use emotions in predicting the use of certain website features and content (Chapter 7, Section 7.6.5.4).

The *confirmed Phase IV rules* are:

1. IF user reports at *login interest* > 1 THEN website *highlights* feature for *language selection*, i.e., links for selecting Bosnian or English as the language of the website.

The rule was supported by the Study 5 correlation finding between *Interest* and Bilingual content/selecting language (*Study 5*: $r = .817$, $p = .001$; $X^2(8) = 21.67$, $p = .006$; Somers' $d = .563$, Gamma = 1.0, $p = .001$; *Study 4*: $\rho = .277$, $p = 0.004$; *Study 3*: $X^2(16) = 26.39$, $p = 0.049$; Somers' $d = .101$, Gamma = .143, $p = .223$).

2. IF at login ***interest*** ≤ 1 (mildly felt or less) THEN website *hides* links for *selecting a language* for the website.

The rule coincides with a classification rule extracted from Study 5 website interaction data, stating: *Interest L* ≤ 1 : *Language selection*=None (2.0/1.0). However, hiding of language links is not implemented on the website, as this feature is essential for using the website content.

3. IF user reports at login ***interest*** ≥ 3 THEN website *highlights* links to *articles* and *news* content, by highlighting the Articles link in the main website menu, and articles' titles and *articles' recommendations* on all website pages.

The rule coincides with the classification rule extracted from Study 5 website interaction data (Appendix N), stating: (*Interest L* = 4) \Rightarrow *Articles* and news content=One (6.0/1.0). Moreover, it is supported by Study 5 correlation findings (Appendix M): *Interest* and *Articles* and news content (*Study 5*: $r = .591$, $p = .033$); and Study 5 interview findings that when long-terms users experience *Interest L* ≥ 3 AND *Joy L* ≥ 3 THEN *Articles* content is viewed.

Note that the Phase IV rules stated interest ≥ 1 ; however the condition has been made more strict with regards to the intensity of the emotion (should be greater than intensity 3) in light of the new findings.

4. IF user reports at login ***disgust*** ≥ 2 THEN website *highlights* the following features: links to ***knowledge base*** content, by highlighting the Knowledge base link in the main website menu, and Knowledge base articles' titles on all website pages; and *Knowledge base content recommendations* on Knowledge base pages.

The rule coincides with a classification rule extracted from Study 5 website interaction data, stating: (*Disgust L* ≥ 2) \Rightarrow *Knowledge base content*=More (5.0/1.0)

5. IF user reports at *login anger* = 0

THEN website highlights the following features:

forum discussions' recommendations on Forum main page

AND within edit profile page options for *defining user interests* by highlighting the titles and background of interest categories

ELSE IF *login anger* ≥ 1

THEN website hides the following features:

forum discussions' recommendations on Forum main page by changing their background colour to a less visible or more transparent one

AND within edit profile page the *interest categories* by showing only a *Define interests* link which if clicked on presents all interest options.

The rule was supported by two Study 5 correlation findings:

- *Anger* and Forum discussions' recommendations (Study 5: $X^2(6) = 15.92, p = .014$; Somers' $d = -.352$, Gamma = $-.655, p = .113$; Study 4: $X^2(16) = 32.82, p = 0.008$; Somers' $d = -.146$, Gamma = $-.200, p = .193$)
- *Anger* and Defining personal interests (Study 5: $\rho = -.545, p = .024$; Study 4: $\rho = -.206, p = 0.039$)

0.1.1 Special cases: Phase IV rules which require consideration

The following rules require additional consideration. Some were interesting cases that are however not advisable to be implemented on the website in the same form (e.g. rule 9).

Other rules were partially supported and needed adjustments, or contradicted by the follow-up findings.

6. IF user reports at *login fear* = 0 THEN website *highlights* the features that enable *filtering* and sorting of *search outcomes*

ELSE IF login *fear* ≥ 1 THEN website *hides filters* for search results by presenting only a link Filter which if clicked on presents the filtering options.

Study 5 correlation findings showed that this rule does not apply to filtering all content. Fear increases the liking of filtering by cancer type, as seen in the relation: *Fear at login* and Filtering content by cancer type (Study 5: $r = .655$, $p = .04$; $X^2(1) = 4.29$, $p = .038$).

7. IF user reports *during* website use *interest* ≤ 2 THEN website *highlights* tools for searching including *search boxes* on Home page, on Blogs and Forum main page.

The rule was partially supported by the Study 5 correlation finding between: *Interest* experienced at *login* and Search functions or Blog search (Study 5: $r = .726$, $p = .008$; $X^2(8) = 16.93$, $p = .031$).

8. IF user reports at *login sadness* ≥ 3 (AND surprise ≤ 3) THEN website *highlights* links to *articles* and *news* content, by highlighting the Articles link in the main website menu, and articles' titles and *articles' recommendations* on all website pages.

The rule was partially supported by the Study 5 interview findings which showed that when long-term users experience *Sadness* $L=1$ THEN *Article recommendations* are viewed.

Hence, the rule is adjusted to:

IF user reports at *login sadness* ≥ 1 THEN website *highlights* links to *articles* and *news* content, by highlighting the Articles link in the main website menu, and articles' titles and *articles' recommendations* on all website pages.

9. IF at login *surprise* = 0 (*not felt*) THEN website *highlights* links for *selecting a language* for the website.

This Phase IV rule is contradicted by the classification rule extracted from Study 5 website interaction data, stating: (*Surprise* L \leq 0) \Rightarrow *Language selection=*None (4.0/1.0). However, as hiding the language links is not advisable, given that the two rules contradict each other, *the recommended action is not to apply any adaptation to language selection if surprise is not felt at login.*

O.2 Other emotion-based rules extracted from significant findings

O.2.1 Login-emotions

10. IF user reports at login *interest* \geq 1 THEN website *highlights* feature for *adapting text colour* ELSE IF login *interest* = 0 THEN website *hides* feature for *adapting text colour*.
11. IF user reports at login *interest* \geq 1 THEN website *highlights* the link for *edit profile* page, and all notifications for editing profile including – *orange triangle* on the notifications bell and *red rectangle* notifications.
- ELSE IF login *interest* = 0 THEN website *hides* the notifications for editing profile including – *orange triangle* on the notifications bell and *red rectangle* notifications.
12. IF user reports at login *interest* $>$ 2 THEN website *hides* emotion reporting by disabling automatic appearance of *Emotion Tool* at rating, and decreasing visibility of the *Emotion Tool* button.
13. IF user reports at login *surprise* = 4 THEN website *highlights* links to *blog* and *forum* content, by highlighting the *Blog* link and *Forum* link in the main website menu, and blog posts' and forum discussions' titles on all website pages.
14. IF user reports at login *surprise* = 0

THEN website highlights the following features: button *Add to readlist* in all content types; *information bubbles* within edit profile page; link for *edit profile* page, and all notifications for editing profile including – *orange triangle* on the notifications bell and *red rectangle* notifications;

AND website hides the following features: *rating content* by showing only a link *Rate* which if clicked on presents the rating stars and latest content rating.

ELSE IF *login surprise* ≥ 1

THEN website hides the following features: button *Add to readlist* in all content types; *information bubbles* within edit profile page; notifications for editing profile including – *orange triangle* on the notifications bell and *red rectangle* notifications; reminder *What did you think about the following content?* from user profile page;

AND website highlights the following features: stars for *rating content* in all content types; feature for *language selection*, i.e., links for selecting Bosnian or English as the language of the website.

15. IF user reports at *login disgust* = 0

THEN website highlights the following features: buttons for *adapting text size*; link for *edit profile* page, and all notifications for editing profile including – *orange triangle* on the notifications bell and *red rectangle* notifications; *Private messages* link and *Contact psychologist* buttons that enable the user to establish private communication with a psychologist; within all content types the text box for *commenting* and existing *comments*.

ELSE IF *login disgust* ≤ 1

THEN website highlights on Forum main page *forum discussions recommendations*.

ELSE IF *login disgust* ≥ 1

THEN website hides the following features: notifications for editing profile including – *orange triangle* on the notifications bell and *red rectangle* notifications; *Contact psychologist* buttons on the Profile page, Chatroom and other pages as these might cause unease in users thinking they are asked to start a communication with a psychologist; within all content types the text box for *commenting* and existing *comments*.

ELSE IF *login disgust* = 3 (very)

THEN website highlights on Forum main page *forum discussions recommendations*.

ELSE IF *login disgust* = 4 (extremely)

THEN website hides on Forum main page *forum discussions recommendations* by changing their background colour to a less visible or more transparent one.

16. IF user reports at *login anger* = 0

THEN website highlights the following features: *language selection*, i.e., links for selecting Bosnian or English as the language of the website; the question *Is this a useful recommendation?* and the answer buttons for all content recommendations;

AND website hides *rating content* by showing only a link *Rate* which if clicked on presents the rating stars and latest content rating.

ELSE IF *login anger* <= 2 THEN website highlights buttons for *sharing content*.

ELSE IF *login anger* ≥ 1

THEN website hides the following features: does not show the question *Is this a useful recommendation?* for all content recommendations;

AND website highlights stars for *rating content* in all content types.

17. IF user reports at *login sadness* = 0

THEN website *highlights* the following features: links or background of individual *search results*.

ELSE IF *login sadness* ≤ 2

THEN website *highlights* within all content types the text box for *commenting* and existing *comments*.

ELSE IF *login sadness* ≥ 1

THEN website *hides* the following features: search options by reducing the visibility of the search tool and replacing individual *search results* with a link which if clicked on expands all search outcomes.

18. IF user reports at *login shame* = 0

THEN website *highlights filters for content recommendations* on user profile page.

ELSE IF *login shame* ≥ 1

THEN website *hides filters* for content recommendations on user profile page by presenting only a link Filter which if clicked on presents the filtering options.

O.2.2 During-use emotions

19. IF user reports *during* website use *interest* = 4 (extremely felt) THEN website *highlights* the following features: button *Add to readlist* in all content types, *filters for content recommendations* on user profile page.

20. IF user reports *during* website use *interest* ≥ 3 THEN website *highlights* the link to *user profile* page.

The rule is extracted from multiple findings, as follows:

- Longitudinal website use data (Appendix K): *Interest L* and *content recommendations on profile page* ($\rho = -.968, p = 0.007$)
 - Study 5 correlations between discrete pre-use emotions and usefulness of personalisation features (Appendix M): *Interest* and *User profile content* (Study 5: $X^2(8) = 16.49, p = 0.036$, Somers'd = .246, Gamma = .429, $p = .285$)
 - Study 3 correlations between discrete pre-use emotions and usefulness of personalisation features (Appendix M): *Interest* and *Content recommendation matched to personal interests* (Study 3: $X^2 = 27.23, p = 0.039$).
21. IF user reports *during* website use **interest** ≥ 3 THEN website *highlights* within all content types the text box for *commenting* and existing *comments*.
 22. IF user reports *during* website use **surprise** ≥ 1 THEN website *highlights* on Articles pages *recommendations for articles*.
 23. IF user reports *during* website use **sadness** ≥ 4 THEN website *highlights* the background or title of *content categories* in all content types.
 24. IF user reports *during* website use **sadness** ≥ 2 THEN website *highlights* feature *notifications bell with orange triangle*.
 25. IF user reports *during* website use **anger** = 0 THEN website *highlights* the link for *edit profile* page, and all notifications for editing profile including – *orange triangle* on the notifications bell and *red rectangle* notifications.
 26. IF user reports *during* website use **disgust** = 0 THEN website *highlights* the button for opening the *Emotion Tool*.
 27. IF user reports *during* website use **fear** = 0 THEN website *highlights* within user profile page the *red rectangle* notifications.

O.2.3 Joint effect of several emotions

28. IF user reports at *login fear* ≥ 2 AND *sadness* = 0 THEN website highlights links to *forum* content, by highlighting the *Forum* link in the main website menu, and forum discussions' titles on all website pages.
29. IF user reports at *login fear* ≥ 2 AND *sadness* ≤ 1 AND *anger* ≥ 1 THEN website highlights tab and link for user *Blogs* on user profile page.
30. IF user reports at *login sadness* ≥ 3 AND *anger* = 0 THEN website highlights within edit profile page options for *defining user interests* by highlighting the titles and background of interest categories.
31. IF user reports at *login interest* > 1 (mild intensity) AND *surprise* > 0 (not felt at all) THEN website highlights feature for *language selection*, i.e., links for selecting Bosnian or English as the language of the website.
32. IF user reports at *login interest* ≤ 2 AND *shame* > 2 THEN website highlights the button for opening the *Emotion Tool*.
33. IF user reports at *login interest* ≤ 2 AND *shame* ≤ 2 THEN website hides emotion reporting by disabling automatic appearance of *Emotion Tool* at rating, and decreasing visibility of the *Emotion Tool* button.
34. IF user reports at *login surprise* = 0 AND *joy* = 0 THEN website highlights within user profile page the feature *What did you think about the following content?*
35. IF user reports at *login surprise* = 0 AND *joy* > 0 THEN website hides from user profile page the feature *What did you think about the following content?*
36. IF user reports at *login surprise* ≤ 1 AND *during website use joy* ≥ 1 THEN website highlights the feature for providing *feedback about the usefulness* of the recommendation user is viewing at that moment, and the resulting *adaptive storyline* content recommendations.

37. IF user reports at *login surprise* ≥ 1 AND *during website use surprise* ≥ 2 THEN website highlights on Forum main page *forum discussions recommendations*.
38. IF user reports at *login surprise* = 0 AND *shame* = 0 AND *joy* ≤ 3 THEN website highlights the background or titles of *content recommendations* on user profile page.
39. IF user reports at *login shame* = 0 AND *during website use fear* ≤ 2 THEN website highlights the background or titles of *content recommendations* on user profile page.

Results also indicate that the following rule holds for *language selection*:

40. IF at *login surprise* = 0 (*not felt*) OR *login interest* ≤ 1 (*mildly felt or less*) OR IF at *login interest* > 1 AND *surprise* = 0 OR IF *login anger* ≥ 1 OR IF *during use interest* = 4 (*felt extremely*) THEN website can *hide* links for *selecting a language* for the website.

However, since this is an essential feature enabling users to switch to content in the language they understand, it is not recommended that hiding adaptation is implemented for this feature. Instead, providers could decide for adaptivity in this case, whereby user location could be detected and based on that automatic adjustment of the website language can be made.